ATER AND RELATED LAND RESOURCES
CHAMA-OTOWI SUB-BASIN
UPPER RIO GRANDE BASIN
NEW MEXICO

Confluence of clear Rio Grande and muddy Rio Chama

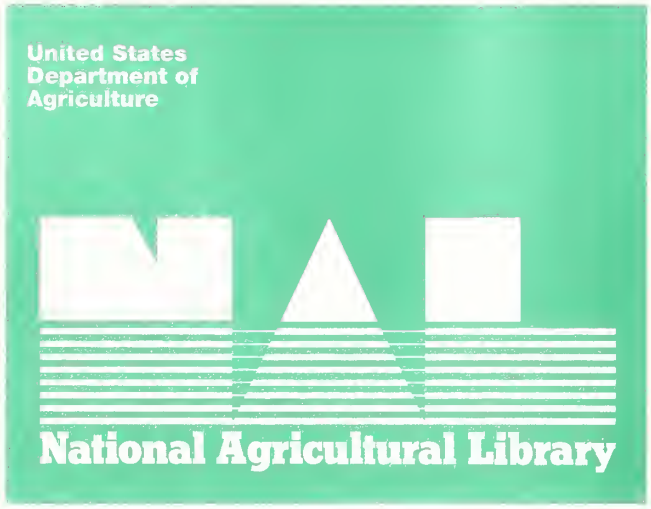
A Report Based on a Cooperative Study by

UNITED STATES DEPARTMENT OF AGRICULTURE

and the

NEW MEXICO STATE ENGINEER

PREPARED BY
Economic Research Service–Forest Service–Soil Conservation Service
ALBUQUERQUE, NEW MEXICO—1968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WATER AND RELATED LAND RESOURCES

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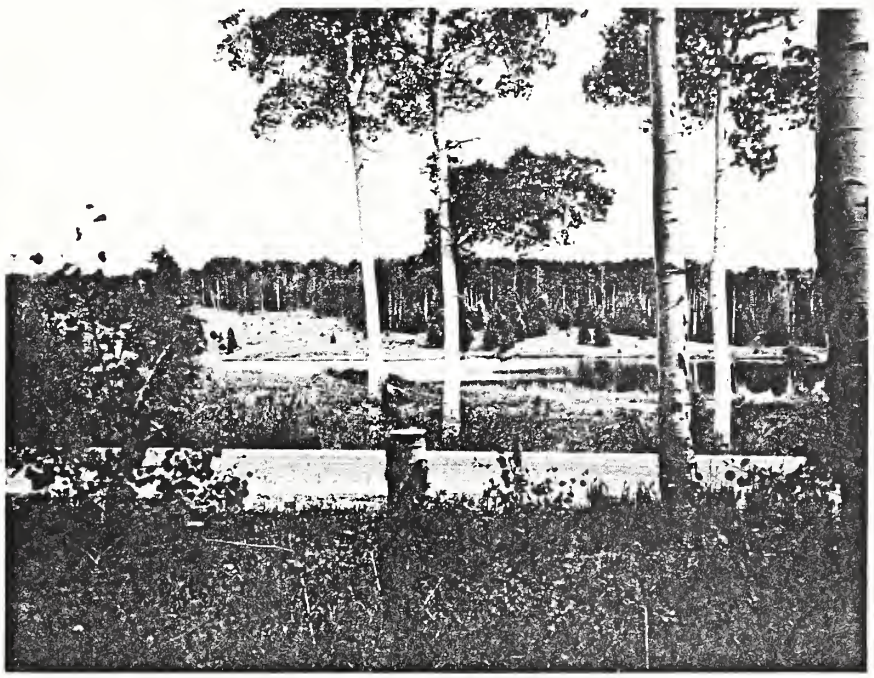

Recreation potential is typified by the Canjilon Lakes area

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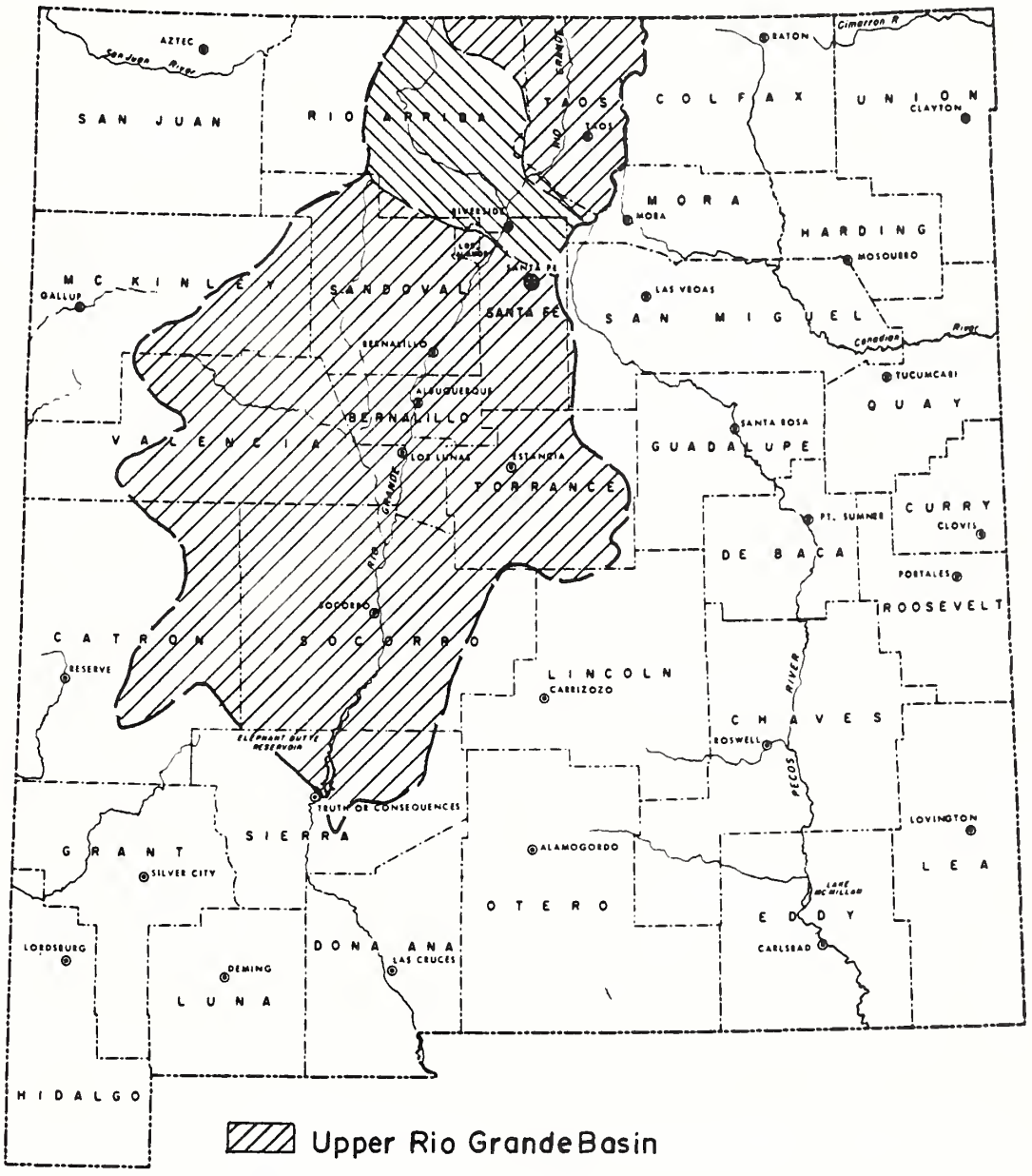

UPPER RIO GRANDE BASIN
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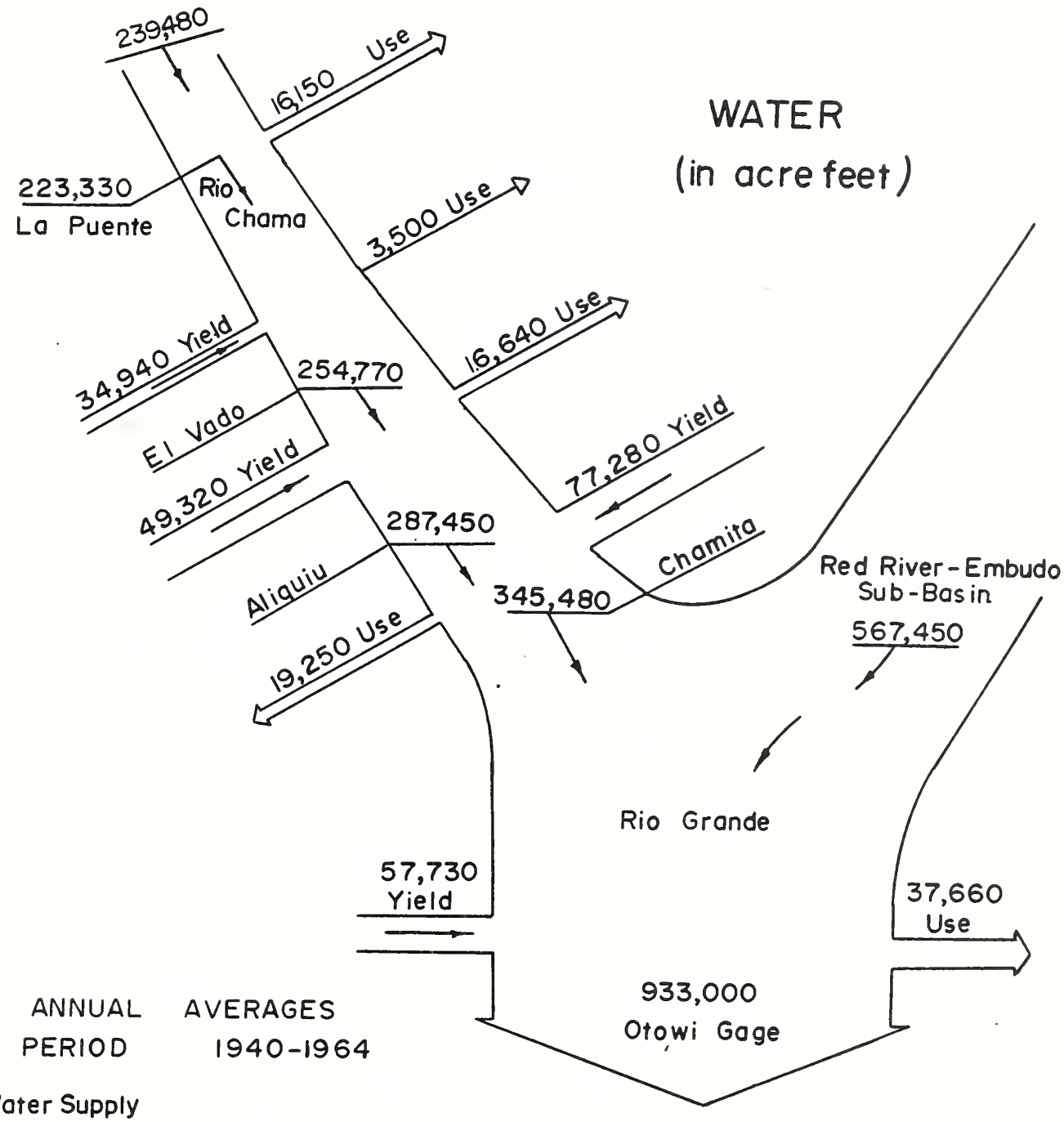

ANNUAL AVERAGES
PERIOD 1940-1964

Total Water Supply

Rio Chama	401,020 Ac. Ft.
Rio Grande	625,180 Ac. Ft.
	1,026,200 Ac. Ft.

Identified Use In Sub-Basin

Irrisation	61,300 Ac. Ft.
Phreatophytes	25,300 Ac. Ft
Domestic	2,800 Ac. Ft.
Reservoir Evaporation	3,800 Ac. Ft.
	93,200 Ac. Ft.

Note: Net yield to streamflow between gaging stations is based on identified uses.

WATER RESOURCE of the CHAMA-OTOWI SUB-BASIN UPPER RIO GRANDE BASIN NEW MEXICO

CHAMA-OTOWI SUB-BASIN OF THE UPPER RIO GRANDE BASIN
NEW MEXICO

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S U M M A R Y

Objectives and Scope of Study

The general purpose of this cooperative survey report is to present information on water and related land resources in the Chama-Otowi Sub-Basin in the Upper Rio Grande basin, New Mexico. 1/ Problems concerning the conservation and use of land and water are identified and recommendations are made for solving some of these problems through programs of the U. S. Department of Agriculture and other Federal and State agencies.

There is emphasis on opportunities for development through initiative of local sponsors in project-type developments. Developments under the provisions of the Watershed Protection and Flood Prevention Act (Public Law 566) is the primary example. Other opportunities exist for individual and group developments. Farm and ranch planning and development measures are examples.

The purposes considered eligible for technical and financial assistance are land use and treatment, flood prevention, agricultural water management, municipal and industrial water supply, water quality management, recreation, and fish and wildlife.

In this cooperative survey report, it is recognized that social, institutional, legislative, and economic considerations may impede some recommended developments and increase the interest in others. These factors may establish the need for studies beyond the scope of this survey. These

1/ The term "related land" as used here refers to land that is associated with water resource developments either through the effects of the land on the water resources, or the effects of the water resources and their development on the land.

programs are treated only to the extent of discussing impacts, both adverse and beneficial, of recommended developments and their capability of meeting projected demands.

The total potential development program recognized in this report as being needed to meet total demand by the year 2020, has been carefully examined to extract that part which can reasonably be expected to be developed by 1980 (See Section IX). This program is designated as the U. S. Department of Agriculture Water and Related Land Resource Projects and Measures Recommended for Early Action.

Specific objectives of the study were:

1. Identification of areas where vegetative manipulation might improve water yield.
2. To provide a basis for coordinated U. S. Department of Agriculture program activity in watershed protection, flood prevention, and agricultural water management.
3. Identification of opportunities for improving the agricultural economy.
4. Appraisal of opportunities of meeting local objectives with U. S. Department of Agriculture project-type programs.
5. Appraisal of development needs that contribute to a plan for coordinated control, regulation, and management of the water and related land resources.

6. Appraisal of the potential, needs, and desires of the human resource and indicate programs, procedures, and assistance possible and necessary to help the local people provide their full contribution to the economy and culture of the sub-basin.

The study was carried out on a reconnaissance level with data from previous investigations used whenever possible.

Size and Location of Sub-Basin

The Chama-Otowi Sub-Basin is in north central New Mexico. It includes all of the Rio Chama in New Mexico and that portion of the Rio Grande and tributaries between the U. S. Geological Survey stream flow gages at Embudo and Otowi. It contains approximately 2,445,000 acres (3,820 square miles).

Problems and Needs

Problems are in four general categories:

1. Water management which includes problems of drainage, water availability, irrigation water management, phreatophytes, and pollution.
2. Floodwater, erosion, and sediment damage.
3. Agricultural problems include size of farm unit, cropping patterns, range management, range and forest fires, improper utilization of private forest land and timber resources, inadequate agricultural marketing and processing facilities, and impaired natural beauty.
4. General economic problems are: high unemployment, low income, and a high percentage of people on welfare.

These problems can best be solved through interest and activities of local people and with public and private organizations as they become responsible for conservation and development of resources in the sub-basin. This report will assist local people, public and private agencies to appraise their problems, needs, and resources with alternative solutions presented.

Findings and Conclusions

Two types of programs are considered in this report. The early action program includes those projects and measures which are feasible and needed to solve urgent problems and can be installed through 1980. The total potential development program includes those programs which will meet the total demand by the year 2020.

1. Approximately 50,600 acre-feet of water is consumed annually by an estimated 12,200 acres of phreatophytes. This contributes to the overall limitations of water supplies in the Rio Grande Basin. Federal or State action programs are needed to help solve this problem.

2. About 4,500 acre feet of soil is eroded annually. Gross erosion rates vary from less than one to more than seven acre-feet of soil lost per square mile annually! About 90 percent of the erosion occurs in Land Resource Area 36 (Present Erosion Status Map and Major Land Resource Areas Map, Appendix I). Heavy concentrations of sediment (up to 58,500 parts per million) is a major factor affecting water quality of the Rio Chama and Rio Grande.

An intensive land treatment project area is proposed under the early action program. The project would also increase forage production and improve water quality. Estimated benefits include: (1) Reduction of average annual sediment yield to downstream damaged areas of 408 acre-feet, and (2) Average annual increase of 29,168 tons of forage. Estimated initial installation cost of this treatment program is $3,075,165. The average annual cost, including operation and maintenance, is estimated to be $484,312; and the average annual benefit is expected to be $1,021,781.

3. Flood damage presently occurs on about 12,000 acres of irrigated land. Average annual damage is $682,000. Most of this damage occurs along the lower reaches of the Rio Chama, the Rio Grande, and major tributaries.

   Three watersheds have potential for development in the early action program under the authority of PL 566, as amended. One project for flood prevention could be developed under the Resource Conservation and Development program. These proposed projects could reduce the overall flood damages by about 53 percent. Runoff from about 174,293 acres could be controlled by these projects.

4. Two hundred separate irrigation systems are in need of consolidation, reorganization and improvement. Some of this work is now being done under various Federal and State programs. It is estimated that 155 systems could be improved by 1980 through the Agricultural Conservation Program at an

estimated cost of $2,021,800.

5. About 13,000 acres of irrigated lands in 10 areas are affected by a high water table and salt accumulations. Reduction of the sediment buildup in channels of the Rio Grande, Rio Chama, and principal tributaries could alleviate some of this problem. In addition, it is estimated that drainage projects on 5,000 acres could be established under the early action program at a cost of $105,000.

6. About 200,000 acres in small scattered tracts have soils and topography suitable for irrigation. Bringing these lands into crop production would depend upon obtaining a water supply and demand for crops that can be grown.

7. Since 1949, the production of small grains and dry beans has decreased while the acreage devoted to fruit production has increased. About three-fourths of the farm income in Rio Arriba County is derived from livestock sales with cattle and sheep accounting for 99 percent of such sales. Farm crops account for the remaining income.

8. Timber harvest on the Carson and Santa Fe National Forests may be accelerated to attain the allowable annual cut of 42,400,000 board feet if the demand dictates. This would be an increase of 80 percent over the present annual harvest.

9. Economic impact of USDA programs possible by 1980.

Measures	Estimated economic benefit after installation	
	Average-annual man-years employment	Increase in average annual income (dollars)
Structural	5	19,000
Land Treatment	30	120,000
Other Projects	67	236,000
Total	102	375,000

10. Economic impact of USDA programs possible in years 1980-2020

Measures	Estimated economic benefit after installation	
	Average-annual man-years employment	Increase in average annual income (dollars)
Structural	27	107,000
Land Treatment	171	683,000
Other Projects	382	1,338,000
Total	580	2,128,000

11. Average annual monetary and physical expression of possible land treatment accomplishment in next 15 years, early action program, for total sub-basin under USDA programs:

(a) Increased water yield	$344,800
(b) Reduction in sediment	259,800
(c) Increased meat production	595,500
Total dollar benefit	$1,200,100

12. Potential average annual monetary value of land treatment from 1980-2020

(a) Increased water yield	$2,347,800
(b) Reduction in sediment	153,900
(c) Increased meat production	1,751,500
Total	$4,253,200

13. Peak streamflow does not coincide with peak diversion demand. In the tributary areas diversion demand usually exceeds the available water supply during the summer months. Streamflow regulation or irrigation water storage is needed to balance the available supply with the needs.

Reservoir sites are available and preliminary investigations have been made in several areas. Some of these problems will be solved by units

of the San Juan-Chama project of the Bureau of Reclamation. Other areas are being considered as alternate units under this project. Some projects, combining irrigation and water storage, may be built under other programs.

14. Surface waters are fully appropriated. Consequently no new depletions of the available supply are allowed except for stock water and domestic purposes. Identified water depletions are estimated to be 93,200 acre feet annually. Imported waters by the U. S. Bureau of Reclamation's San Juan-Chama project will satisfy some of the irrigation demands and may provide additional water for areas in the basin and downstream.

15. Development of recreation facilities offers one of the greatest potentials for providing additional income and employment. Six reservoir sites for recreation and irrigation water storage are proposed as possible Resource Conservation and Development projects using funds other than U. S. Department of Agriculture. Estimated construction cost of these six reservoirs is $3,365,700.

The National Forest recreational survey and the Division of Wildlife Management, in cooperation with the New Mexico Department of Game and Fish, have designated 27 sites on the Carson National Forest as having potential for water impoundment.

It is estimated that the San Juan-Chama project will provide an estimated additional 22,000 man-days of fishing annually in Heron Reservoir and will double the man-days of fishing on the Rio Chama to about 30,000 man-days.

16. Nineteen communities need water distribution and/or sewer systems. It is estimated that project action to solve these needs could be initiated in 15 of these communities under the early action program.

17. Nineteen additional Resource Conservation and Development projects are proposed. These projects would include a landing strip, skiing facilities, access roads, nature trails, vocational schools, and other measures.

18. Terracing project area proposed on more than 4,000 acres.

II

I N T R O D U C T I O N

Why the Study Was Needed

The Water Resource Planning Act of 1965 makes a new approach toward reconciling the conflict between the inseparability of our larger water and related land resource problems and the separation interposed by our Federal system between State and Federal power to act. Concern in planning the use of water and related land resources must include both quantity and quality of our total environment. To accomplish this planning task means we must deal with a great multitude of problems which are so interconnected that none can be solved satisfactorily in isolation from others. Adequate solutions, therefore, are impossible without comprehensive planning that takes account of all significant relationships. Fully meaningful comprehensive planning cannot be done separately by the Federal government or the states including local governments. It can only be done well by the two acting in full collaboration. The Water Resources Planning Act provides the means for this collaboration. (Caulfield, 1965).

The U. S. Department of Agriculture-New Mexico river basin survey's primary purpose is to determine where improvements in the use of water and related land resources, which have social and economic aspects, might be made with the assistance of the Department projects and programs.

The State of New Mexico assists local people and their organizations in the conservation, development, and management of water resources through Federal-State-local projects. One responsibility of the New Mexico State Engineer is to cooperate with Federal agencies, State and local groups, and to coordinate State-Federal activities to help solve water and related land problems for the people of New Mexico.

To assist local people in solving their problems, the State and the U. S. Department of Agriculture need information on water and land resource problems. This information will indicate the opportunities for more effective use and development of water and related land resources.

The magnitude and significance of these problems and possible solutions are indicated in this report. It is necessary to know the effect of Federal and State programs in solving the problems. The extent to which various U. S. Department of Agriculture programs can assist in meeting these identifiable needs will be assessed.

Purpose and Objectives

The purpose of this study is to contribute to an orderly plan for the development, management, and use of water and related land resources of the Chama-Otowi sub-basin of the Upper Rio Grande Basin. This study will provide the local people, the State of New Mexico, and Federal agencies with possible courses of action for (1) the development, conservation, and use of the natural resources, and (2) to improve the economic and social opportunities of the people.

This study has the following five principal objectives:

1. To identify broad areas which are feasible for vegetative manipulation to improve water yield and to appraise the economic effects of such manipulation.
2. To provide a technical basis for more effective coordination of U. S. Department of Agriculture programs for resource management with similar activities of local, State, and other Federal agencies.

3. To identify and describe the opportunities to assist in the full utilization of the human resources in improving the economic and cultural status of the sub-basin.
4. To appraise opportunities of meeting local objectives through existing or future local and U. S. Department of Agriculture programs.
5. To appraise the needs of the sub-basin and to contribute to the development of a plan for the coordinated orderly control or regulation, management, and use of natural resources.

Description of Study Area

The Chama-Otowi Sub-Basin, located in north central New Mexico, is one of the six sub-basins in the study area. Sea level altitudes range from 5,590 feet above mean in the valley at Espanola to 13,100 on Truchas Peak. A wide variety of topography and vegetative cover occurs in the area. The Rio Chama is the main drainage and important tributary to the Rio Grande. The lower area has a temperate semi-arid climate but severe winter weather and heavy snow occur in the high mountains.

The annual precipitation is low. At elevations of 5500 to 7000 feet, about two-thirds of the total precipitation occurs during summer thunderstorms, and one-third as winter snow. Above 7000 feet, one-half of the precipitation is summer showers and one-half is winter snow.

This area is one of the oldest continuously occupied areas in the United States and the site of the first Spanish settlement in New Mexico with the first exploration by Coronado in 1540. Today there are three ethnic groups in the area: (1) the native Indian, (2) descendants of Spanish settlers, and (3) and people of Anglo extraction. The area is a rural farm and non-farm population with Espanola and vicinity showing urban

characteristics. Rio Arriba County has been declared an economically depressed area, and the entire sub-basin is within the Four Corners Economic Development Region. About 15 percent of the population is on public welfare.

Sparse vegetative cover caused by unwise land use and arid climatic conditions contributes to severe erosion and sediment problems. Availability of the limited supply of water may be a limiting factor for future development in the area. There are thousands of acres of vegetation that can be manipulated to increase the amount and availability of this limited water supply.

USDA Agencies Participating in the Study

USDA agencies participating in the study are the Soil Conservation Service, the Forest Service, and the Economic Research Service. The study is in accordance with the Memorandum of Understanding, dated February 2, 1956, between the Administrator of the Soil Conservation Service, the Administrator of the Economic Research Service, and the Chief of the Forest Service.

Authority for Study

The Office of the New Mexico State Engineer, the sponsoring and cooperating agency, requested USDA to conduct a study in the Upper Rio Grande Basin. This study was made under the authority of Section 6 of the Watershed Protection and Flood Prevention Act of the 83d Congress (Public Law 566, as amended) which authorizes the Secretary of Agriculture to cooperate with other Federal, State, and local agencies in their investigations of watersheds, rivers, and other waterways to develop coordinated programs.

Water-Rights Administration [1]

New Mexico law provides that the surface and underground waters of the State belong to the public and are subject to appropriation for beneficial use. Such use is the basis, the measure, and the limit to the right to use of water, and priority in time gives the better right. The underlying principle is known as the appropriative doctrine of water rights. Where it applies, the mere physical presence of water upon, within, or adjacent to land does not confer upon the owner of the land ownership of the water or a right to its use.

Water rights in New Mexico are administered by the State Engineer in accordance with provisions of the constitution and the statutes, the adjudication of the courts, the terms of interestate water compacts, and the rules and regulations of the State Engineer. Seven interstate compacts to which the State is signatory affect development and use of water in New Mexico. Situations in which there is intimate relationship between occurrence of ground water and the flow of surface streams require coordinated administration of diversions by wells and by surface works in order to insure that valid water rights are served and that the State's ability to meet interstate water-delivery obligations is preserved.

About 840 square miles of the Chama-Otowi Sub-Basin are within the boundaries of the declared Rio Grande Underground Water Basin and hydrographic surveys are underway preparatory to adjudication of water

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1/ This statement was prepared by the Office of the New Mexico State Engineer

rights along Rio Chama below Abiquiu Dam, Rio Santa Cruz, and Pojoaque-Tesuque-Nambe streams. Waters of the sub-basin are fully appropriated; consequently no new depletion of the available surface water supply is allowed. Permit to change the place and the purpose of existing water uses may be obtained provided such changes can be made without impairment of existing rights and are in agreement with interstate water compacts; and, to this extent, new water uses served by the existing supply are allowed. New uses may also be allowed if their effect on flows of the Rio Grande can be offset by imported water. Also ground waters may be appropriated for new uses if the effects of such taking on the surface flow of streams are at all times offset by retirement of existing valid surface-water uses.

The Rio Grande Compact, between the States of Colorado, New Mexico, and Texas, apportions waters of the Rio Grande stream system among these states and defines the obligations of the upstream states to deliver water by schedules that establish the outflow which must be maintained with a given inflow. New Mexico's obligation to deliver water to Elephant Butte Dam is established by the flow of the Rio Grande at the Otowi gage. The compact requires that appropriate adjustments be made to stream flows to reflect new or increased depletions in the applications of the schedules. It defines and limits storage rights and protects the priority of the storage right of Elephant Butte Reservoir over later upstream storages. The compact provides that the state having the right to the use of any water imported to the Rio Grande Basin shall be given proper credit therefor in the application of the schedules for delivery of water. Works to import water to Upper Rio Chama are now being constructed. (See San Juan-Chama Project, page 91).

How the Study was Made

The investigation was made at a reconnaissance level with more intense studies of those watersheds where problems of floodwater, sediment, agricultural water management, and recreation might be solved under provisions of Public Law 566. The Truchas Drainage of the Sebastian Martin-Black Mesa Watershed was studied intensively to provide a basis for judgment and for making projections throughout the sub-basin. For watersheds where authorities of PL 566 might be applicable to solve problems, specific watershed investigation reports were prepared. The conservation needs inventory of watersheds was used to determine problems of flood damage and irrigation and drainage needs.

Uses of the Report

This report will inform local people and organizations of possible solutions to some of the water and related land resource problems. It will inform interested parties of USDA programs of assistance to help solve the problems. Possible uses of the report are:

1. To inform landowners of resource problems, alternative courses of action for solving these problems, and the probable results of these courses of action.
2. To indicate to business and community leaders how local and Federal action programs, utilizing natural resources, can support new industry, expand business activity, and encourage growth in the economy.
3. To identify for State and Federal agencies, opportunities for programming coordination of efforts to make maximum contribution toward the conservation and use of natural resources.

4. To help soil and water conservation district boards of supervisors revise and update their long-range programs of work.
5. To help county commissioners evaluate development trends which may serve as a basis for projecting current and future highway needs.
6. To assist the State and County Technical Action Panels to identify rural problems and suggest ways to develop more completely these natural, human, economic, and social resources.

Acknowledgment

Many State and Federal agencies, in addition to the U. S. Department of Agriculture and the State Engineer of New Mexico, have provided data and assistance for this report. Significant contributions have been received from private individuals, business firms, the State's universities, and retired professional people.

III

N A T U R A L R E S O U R C E S

Location

The Chama-Otowi Sub-Basin is in north central New Mexico. It borders Colorado on the north and includes all tributaries to the Rio Chama and the Rio Grande between the Embudo and Otowi stream gages. Most of Rio Arriba County, and parts of Los Alamos, Santa Fe, Sandoval, Mora, and Taos Counties are included.

The sub-basin is about 100 miles long and about 60 miles wide (at the widest point) and includes approximately 2,445,000 acres (3,820 square miles). It comprises 12.5 percent of the area in the Upper Rio Grande Basin. Approximately 27 percent of the land is privately owned, 3 percent is State land, and 70 percent is administered by Federal agencies (50 percent U. S. Forest Service, 10 percent Bureau of Land Management, and 10 percent Bureau of Indian Affairs).

Climate

The climate varies from arid in the Espanola area and lower altitudes to sub-humid in the high mountains. The average annual precipitation ranges from less than 10 inches at Espanola to more than 35 inches in some high mountain areas (Table 1).

About one-third to one-half the average annual precipitation falls as snow during the winter months. The rest of the precipitation falls during summer and fall rains. Thunderstorms of high intensity occur in lower elevations during summer and fall. Temperatures have ranged from a maximum of 106°F at Ojo Caliente and Espanola to a minus 50°F at Gavilan. The mean annual temperature varies from about 50°F in the lower elevations

to about 38°F in mountain areas. The estimated normal frost-free period is 154 days at Espanola and 106 days at Chama.

Physiography and Geology

Land Resource Areas (LRA's) 1/

Land resource areas are geographic areas characterized by particular patterns of soil (including slope and erosion), climate, elevation, water resources, land use, and type of farming.

There are three major land resource areas in the sub-basin:

1. New Mexico Plateaus and Mesas (36). This LRA is located in the southern part at elevations of 5000 to 7000 feet. Topography changes abruptly from smooth nearly level valleys through sloping terrace remnants to steep mesa sides topped by basalt rock. The vicinity of Espanola and Black Mesa is typical. This LRA comprises 21 percent of the study area.
2. High Intermountain Valleys (51). This LRA is typified by the Chama-Tierra Amarilla area of nearly level to sloping valley fills. Altitudes range from 7000 to 9000 feet. It comprises 17 percent of the study area.
3. Southern Rocky Mountains (48). This LRA occurs throughout the sub-basin at altitudes from 5500 to 13,000 feet. The topography is primarily steep mountains dissected by narrow valleys. It comprises 62 percent of the study area.

The areas are all within the Southern Rocky Mountain and the Navajo section

1/ See Appendix I for descriptions and map of Land Resource Areas.

Table 1 - Typical climatic conditions by land resource areas in the Chama-Otowi Sub-Basin, New Mexico long term record

Station	Elev.	Mean annual precip. inches	Oct. through March precip. inches	Winter precip. percent	Mean annual temp. degrees F.	Max. temp. degrees F.	Min. temp. degrees F.	Average annual lake evaporation inches
				NEW MEXICO-ARIZONA PLATEAUS AND MESAS LRA				
Espanola	5590	9.75	3.3	33.5	51.2	106.0	-23	48
Ghost Ranch	6900	10.54	3.9	37.0	-	-	-	46
Alcalde	5680	8.78	3.4	38.1	49.6	100.0	- 7	48
Nambe	6000	9.88	3.5	35.8	50.0 1/	-	-	46
				Frost Free Period at Espanola May 6-October 7, 154 days				
				HIGH INTERMOUNTAIN VALLEYS LRA				
Chama	7850	20.96	10.4	49.8	42.6	99.0	-28	40
El Vado Dam	6750	13.88	6.3	45.3	45.2	101.0	-35	42
Tierra Amarilla	7766	15.99	6.9	43.1	44.1	102.0	-40	42
				Frost Free Period at Chama June 9-September 23, 106 days				
				SOUTHERN ROCKY MOUNTAINS LRA				
Cumbres (Colo.)	10015	33.79	18.0	53.2	-	-	-	36
Bateman Ranch	8900	23.23	10.8	46.8	37.0 1/	-	-	44
Santa Fe Lake	11600	35.10	15.6	44.4	-	-	-	44
Wolf Canyon	8150	21.63	9.0	41.6	39.5	99.0	-41	46

1/ Estimated

of the Colorado Plateaus physiographic provinces.

Geology

Precambrian age crystalline rocks are exposed primarily along the northeastern side of the sub-basin. Volcanic flows are exposed east of Chama and west of Espanola. Approximately 50 percent of the sub-basin is underlain by Cretaceous, Jurassic, Triassic, Permian, and Pennsylvanian age sandstones, siltstones, and shales. Quaternary and Tertiary age rocks including cemented and semi-cemented gravels, sands, silts, and clays underlie the eastern one-third of the area.

Minerals

The primary mining areas are located in the Coyote-Gallinas area, the La Madera-Petaca-Hopewell area, and along the western side of the sub-basin. A deposit of iron ore in the Las Tablas quadrangle was studied by the New Mexico State Bureau of Mines and Mineral Resources, and it is estimated that there are 900 million cubic feet of ore located here. Several oil and gas wells have been developed near the Continental Divide, and the edge of the San Juan River Region coal field is located in the same area. Mica, gypsum, and pumice occur in significant quantities. The large deposits of kaolinite in the Vallecitos area could become important in ceramics and other industries.

Soils 1/

The soils are closely associated with the geologic parent materials. Most are relatively immature and reflect physical characteristics related to the nearby rock formations from which they originate.

Three soil areas of major interest are present. The first is scattered in small tracts throughout the sub-basin. The soils are deep, medium to

1/ A general soil map, tables of characteristics and interpretations and soil association descriptions are located in Appendix I.

fine textured, nearly level and are potentially irrigable. This is represented by Soil Association #8 and comprises 8 percent of the area.

The second is located in the High Intermountain Valley LRA and is developing in clayey alluvium and residuum of the Mancos shale geologic formation. Soils are moderately deep to deep, fine textured, and nearly level to steeply sloping. Erosion on unprotected land is severe and the fine textured sediments from these soils give the Rio Chama its characteristic muddy appearance. This area is represented by Soil Association #4 and comprises 17 percent of the study area.

The third soil area is located in the New Mexico Plateaus and Mesas LRA. These soils are developing mostly in mixed gravelly to clayey materials of the Santa Fe geologic formation. Soils are shallow to moderately deep and coarse textured. Slopes are steep and have poor vegetative cover. The short duration, high intensity type summer rainstorms common in the area erode great quantities of soil materials from the watersheds and deposit it in stream channels already choked with sediments. This area is represented by Soil Association #1 and comprises 16 percent of the study area.

Vegetation

Conifer forests, the major vegetative type, covers 47 percent of the land area. Most of the conifer forest is located in LRA 48. Pinyon and juniper woodlands which occur in each of the land resource areas cover about one-third of the area. Grass and brushland located on about 18 percent of the area is found primarily in LRA 51 with a small acreage in LRA 36.

Bottomland vegetation occupies about 3 percent of the area and is found mostly in LRA 36. (See Vegetation Map, Appendix I)

Table 2 - Land resource areas and vegetative types, Chama-Otowi sub-basin, New Mexico

Land Resource Area 1/	Total Acreage	Percent of Sub-Basin	Vegetative Type (acres)			
			Bottomland Vegetation	Grass and Brushland	Conifer Forests	Pinyon-Juniper Woodlands
36	512,200	21	64,000	68,200	14,500	365,500
51	424,400	17	-	369,100	-	55,300
48	1,508,400	62	-	-	1,151,000	357,400
Total	2,445,000	100	64,000	437,300	1,165,500	778,200

1/ LRA #36 - New Mexico Plateaus and Mesas
#51 - High Intermountain Valleys
#48 - Southern Rocky Mountains

Photo
NM-P533-12

Typical high mountain conifers

Use and Management

The principal land use is for grazing sheep and cattle. Grazing is usually limited to summer months in high mountain areas. In the past much of the grazing area has been misused. Through efforts to control grazing, clear brush, and vegetate some areas, the rangeland now shows an improving trend.

Irrigated crops grown vary from native grass, hay, alfalfa to specialty crops such as chili, corn, tomatoes, and fruits.

Increased agricultural production and increased efficiency of water use can be achieved by improved management techniques.

Water Resources

Water Yields

The average annual precipitation is 3,342,000 acre feet which is equal to 16.4 inches of water over the entire area. Of this amount, 365,550 acre feet leave the sub-basin as streamflow. An annual average of 93,200 acre-feet are consumed by identifiable uses, and the remainder is used on site by vegetation or lost through evaporation.

About 100 square miles is non-contributing to surface runoff. For example, there are several small glacial lakes in the high mountains above Canjilon and several lakes northwest of El Vado that hold all the runoff from their respective watersheds.

Average annual streamflow, 65-year record (1900-1964) of the Rio Grande at Otowi gage, was about 1,126,000 acre feet. At the Embudo gage the flow was about 739,000 acre-feet. the 25-year average (1940-1964) is about 933,000

acre-feet at Otowi gage and 567,450 acre-feet at Embudo. This is a reduction in flow at Otowi of about 17 percent and at Embudo a reduction of about 23 percent.

Geographical and Seasonal Distribution

The three major reservoirs are: El Vado Reservoir, Abiquiu Reservoir, and the Santa Cruz Reservoir. El Vado Reservoir, with a capacity of 194,500 acre-feet, is used to store water for irrigation for the Middle Rio Grande Conservancy District. The Abiquiu Reservoir (U. S. Army Corps of Engineers, 1966, p. 6), $6\frac{1}{2}$ miles northwest of Abiquiu, has a storage capacity of 1,225,400 acre-feet. It is operated as a flood control and sediment retention structure by the U. S. Army Corps of Engineers. The Santa Cruz Reservoir, used to store irrigation water for the Santa Cruz Irrigation District, has a capacity of about 3,750 acre feet.

The estimated water yield by stream reach is shown in Table 3. Areas with high mountain watersheds yield much more to streamflow than do areas of lower elevations. Three high yielding areas are the Rio Chama headwaters to La Puente, the Santa Cruz River above Cundiyo, and the Vallecitos and Tusas Rivers which join to form the Rio Ojo Caliente at La Madera.

Most of the tributary area streamflows are insufficient to meet irrigation diversion demand. Figure 1 of El Rito Creek is a typical example of the monthly streamflow distribution and irrigation demand of the area. The major streamflow from tributaries to the Rio Chama occurs in April and May each year, whereas the peak diversion demand occurs during June, July, and August.

Photo

Snow pack contributes to summer water supply

Table 3, Long term yield distribution by stream reach, Chama-Otowi Sub-Basin New Mexico

Stream Reach	Drainage area square miles	Estimated average annual yield to streamflow, ac.ft/sq.mi. 2/
RIO CHAMA		
Headwaters to La Puente	480 1/	497
Willow Creek	193	81
Ungaged area La Puente to below El Vado Dam	204	95
Below El Vado Dam to near Abiquiu	1293	37
Rio Ojo Caliente above La Madera	419	124
Ungaged area Abiquiu to Chamita	611	46
SANTA CRUZ		
Above Cudijo	86	250
RIO GRANDE		
Ungaged area between Embudo and Otowi	614	65
SUB-BASIN	3900	119

1/ 80 square miles in Colorado

2/ Water yield estimated from gaging station records and streamflow correlations adjusted to reflect effects of man-made depletions.

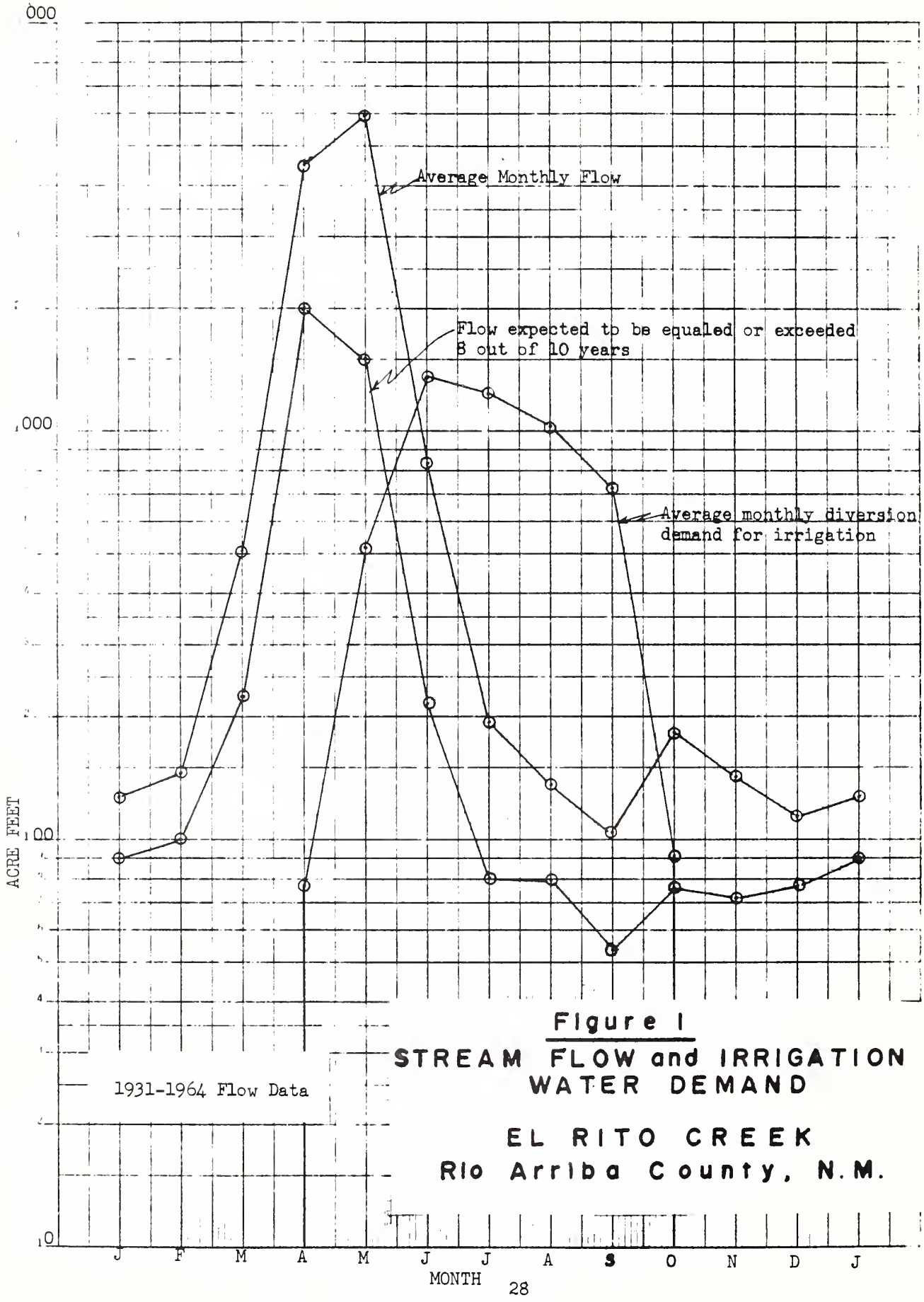


Figure 1

STREAM FLOW and IRRIGATION WATER DEMAND

EL RITO CREEK

Rio Arriba County, N.M.

Water Quality

Surface water and groundwater from wells is usually suitable for irrigation, domestic, and livestock purposes. In municipal water supplies for Chama, Cordova, Coyote, and Vallecitos the iron content is excessive. (Dinwiddie and others, 1966). Fluoride content is above recommended limits in municipal water for Espanola and Youngsville. Water supply for Tierra Amarilla is high in nitrate content. Generally water from deep wells is highly mineralized and often is not potable.

Groundwater Resources

Quaternary alluvium along the major drainages may yield up to 400 gallons of water per minute from large diameter wells up to 100 feet in depth. Wells in the Santa Fe geologic group yield from one to thirty gallons per minute. The San Jose formation of Eocene geologic age yields up to 60 gallons per minute in the northwestern part of the sub-basin. The Nacimiento geologic formation which crops out on the Jicarilla Apache Indian Reservation yields none to very little water. Groundwater yields from wells tapping Cretaceous geologic age strata varies from none to 30 gallons per minute. The Chinle formation of Triassic geologic age yields 30 to 50 gallons per minute from depths less than 300 feet in the Ghost Ranch and Echo Ampitheater quadrangles. The Permian Cutler geologic formation is lenticular in nature and groundwater accumulation would be localized. Significant groundwater developments in the Santa Fe geologic group and Quaternary alluvium would be reflected in streamflows of the Rio Grande and Rio Chama.

There appears to be adequate groundwater in the valley alluviums and much of the Santa Fe group for domestic and livestock supplies. Groundwater

resources for the remaining parts of the sub-basin may or may not be adequate for stock or domestic use dependent on the specific location. In most locations the development of groundwater in sufficient quantities for irrigation and other large uses is not practical because of inadequate yield.

Water Use and Management

The principal use of water, excluding native vegetation, is for irrigation of crops. Approximately 43,100 acres of land are irrigated and these crops consume an average of about 61,300 acre-feet of water annually. In 1966 there were approximately 12,200 acres of phreatophytes. Estimated water use by these plants was 50,600 acre-feet. The estimated average annual streamflow depletion is summarized in table 4.

Table 4, Estimated annual water depletion by kind of use in 1966, Chama-Otowi Sub-Basin, New Mexico

Use	Annual depletion acre feet	Percent of total
Irrigation	61,300	51.7
Phreatophytes	50,600	42.7
Evaporation from reservoirs	3,800	3.2
Domestic	2,800	2.4
Total	118,500	100.0

Approximately 200 irrigation diversion dams and ditches serve the irrigated areas along streams and in the floodplains. These dams are generally logs, brush and rock placed in the stream to divert the water into the ditch. Water control structures in the ditches are usually wood or earth dams and holes cut through the ditch bank for turnouts.

"Acequias" or community irrigation ditches, are operated under the ancient "majordomo" method by local organizations legally recognized under State law. Assessments to the users are commonly met by work required for operation and maintenance of the system. Several permanent type diversion dams and water control structures in the systems are being constructed. Reorganization, consolidation and concrete lining of the ditches will improve irrigation efficiency. The overall irrigation efficiency will continue to be low as long as there are many small ditch systems and small irrigated units.

Fish and Wildlife Resources

Major game animals are mule deer, bear, elk, and turkey. Other game includes blue grouse, sage grouse, antelope, pheasant, and dove. Fur-bearing animals, some of which have commercial value, include mountain lion, coyote, bobcat, badger, beaver, raccoon, mink, muskrat, skunk, pine marten, squirrel, cottontail and jack rabbit. Most of the area is suitable habitat for all game and fur-bearing animals.

There are 672 miles of fishing streams and 4,013 acres of lake waters which provide habitat for cold water fish species. The Rio Grande and Lower Rio Chama and some lakes provide habitat for warm water species. Warm water species are large and small mouth bass, yellow or ring perch, pike perch, bream or bluegill, crappie, and catfish. Cold water fish include native cutthroat, rainbow,brook, brown, Loch Leven, and eastern brook trout.

Quality of the Natural Environment

Scenic Beauty

The basin abounds in spectacular scenic beauty. Clear mountain streams flow

through virgin forests, mountain meadows, and valleys. Some of the most majestic mountain peaks in the State are within and adjacent to the sub-basin. Spectacular and colorful rock formations occur, particularly in Abiquiu area. The Brazos Box is a well known canyon and Brazos Falls is a spectacular sight for those fortunate enough to pass by when spring runoff pours over the cliff.

Several Indian Pueblos add interest for the tourist. The spectacular yellow and gold of the aspens in the fall are an inducement for many trips into the area during this time of year. This scene is enhanced by the bright red strings of chili which drape the sides of the houses during this season.

Photo

Brazos Box Canyon

Photo
NM-P533-1

Fishing enhances family recreation at Santa Cruz Reservoir east of Espanola

Photo

Mule deer abound throughout the area

IV

E C O N O M I C D E V E L O P M E N T

Historical Development [1]

The early inhabitants of this region were members of various Indian cultures, primarily the Pueblos, and are identified with this area at around 1000 to 1200 AD. Both Cabesa de Baca and Coronado contributed much to the exploration of the State in the name of Spain. A member of Coronado's party explored part of what is now Rio Arriba County in 1541.

Early attempts at Spanish colonization met with much harassment from resident Indian tribes and culminated in the great Pueblo Rebellion of 1680. The Spaniards were driven from the area and forced south toward Mexico. Twelve years later Don Diego de Vargas returned and again laid Spanish claim to this land.

The gradual settlement of the area that is now Rio Arriba County began in the late 1600's with Spanish land grants:

(1) to the Indian land holders of record

(2) to settlers in the form of inducements to encourage settlement of particular areas

(3) as aids for land investors

(4) in recognition of and repayment for the services of a particularly in fluential individual.

Title conflicts resulting from these transactions have hampered the issuance of marketable title to the lands even to this date.

1/ This section is based on information in the "Economic Base Report, Rio Arriba County, New Mexico" by Employment Security Commission of New Mexico, New Mexico State Employment Service, 1965, page I-2.

With the signing of the Treaty of Guadalupe Hidalgo in 1848, what is now New Mexico became a United States possession, then a United States Territory in 1851, and finally achieved statehood in 1912. Historical background contributes to current characteristics of population, economic activity, employment, income and growth possibilities and is important in understanding the problems and needs of this sub-basin.

General Description

Population and Population Characteristics

The 1965 sub-basin population was estimated to be 26,000 persons. The Indian population, about 13 percent of the total, is located in pueblos and on the Jicarilla-Apache Reservation.

Rio Arriba County females outnumbered males 50.5 percent to 49.5 percent in 1960. The median age of persons in the county is about 19 years. Of all persons over 25 years of age the median level of education is about 8½ years (Franks and Cornell, Inc. 1962). About 12,500 or 52 percent of Rio Arriba County's 1960 population was less than 20 years old and about 6 percent or 1584 persons are 65 years or older. Thus the remaining 42 percent of the county's population is in the productive age bracket. Of the 1963 total county population of about 25,000, about 91 percent, were rural non-farm residents, while about 9 percent were classified as rural farm residents. The Espanola Valley had an estimated 10,000 persons which is about 40 percent of the total 1963 county population. The county population had an estimated net loss of 800 persons from 1950 to 1960 due to out-migration. The decline in population which began about 1940 appears to have stopped about 1961 or 1962. From 1910 to 1960

the State population increased 190 percent. Rio Arriba County gained only 45 percent compared to Bernalillo County's phenomenal increase of more than 1000 percent for the same period. The county population is projected to be about 27,000 by 1970, 31,000 by 1980, and more than 45,000 by the year 2000 (Figure 2) thus the population is expected to nearly double in the 40 years 1960 to 2000.

Social Structure and Institutional Arrangements

Rio Arriba County is a tri-cultural region composed of Spanish-Americans, Anglos, and Indians. The estimated percentages are Spanish-American, 67 percent; Anglos, 20 percent; and Indians, 13 percent. The American Indian lives under the traditions and customs handed down through the years which directly influence every facet of their lives from the food eaten to the religions embraced. Many rural families have some modern conveniences, while others have none.

During the early Spanish settlement, the Spanish government exercised barriers on trade or communication with other Europeans in this area, to the end that a policy of isolationism was fostered. This resulted in the establishment of a singular culture and vestiges of this policy exist even today.

Among the Spanish-American descendents, the method of handing down land from generation to generation still prevails and has been a major factor in reducing the size of some farms and ranches. Frequently lands are passed on to heirs in equal shares, therefore the size of the individual land parcels become smaller, uneconomic units (Scott, 1967, p. 5). Some lands are currently held by common ownership of the entire community

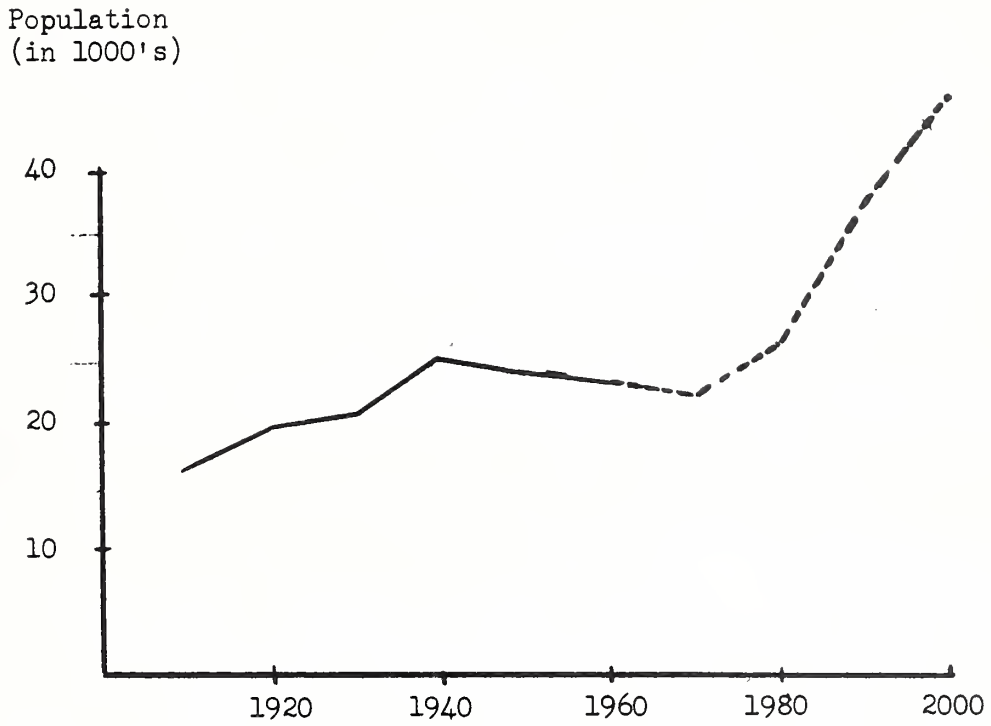


Figure 2 Population growth and projections for Rio Arriba County, New Mexico 1910-2000

Source: Economic Base Report, Rio Arriba County, New Mexico Employment Security Commission 1910-1960. Estimated 1970-2000 based on Bureau of Business Research reprint July and August 1965.

which is not broken into smaller units of ownership. In spite of this, the average farm and ranch size in Rio Arriba County more than doubled from 1945 to 1964. One large land grant held by many of Spanish-American descent is considered by some a heritage which should not be "broken-up". Such attitudes have a direct bearing on the future development of any area in this county or State, and can influence the technology and financing which the people are able to apply to their lands.

Major Types of Economic Activity

Major economic activities include agricultural production, government services, and other industries and service groups. Agricultural production includes crops, livestock, and forestry products. Government services require large number of persons in both defense and non-defense related areas. Other important industry and service segments contributing to income and employment are mining, construction, manufacturing, trade, transportation, communications, public utilities, finance, insurance, real estate, and service groups.

The research facility at Los Alamos has been instrumental in keeping many people in the area who would otherwise have moved to other localities. This facility provides employment for many people residing in the lower reaches of the area.

Recent boosts to employment and income are from construction and government programs and projects. Timber operations are substantial contributors to the economy.

Employment

There has been long-term unemployment especially among the younger and middle-aged workers. During the past two decades younger workers have been migrating. Unemployment in Rio Arriba County ranges from about 16 percent in 1961 to a high of 25 percent in 1964 according to Employment Security Commission data (New Mexico State Employment Service, 1965).

Unemployment fell to about 15 percent during 1966. Seasonal fluctuations of employed persons vary drastically in some industries. Employment in transportation and utilities fluctuated only 11 percent during 1963. Employment in mining varied from a high of 90 to a low of 45 persons. Construction and manufacturing industries' employment fluctuated 238 percent and 293 percent respectively. Trade, service, and other industries varied from 21 to 59 percent.

Income

In 1964, wages and salaries accounted for 63 percent of personal income in Rio Arriba County compared to 71 percent of the personal income in the State from this same source. The largest portion, about one-third, of wage and salary income in the county was from government sources. Transfer payments, including welfare assistance, aid to dependent children and the like, accounted for almost 16 percent of the total personal income in the county in 1964. For the State, these transfer payments amounted to only 7 percent. Personal income in the county has grown steadily since 1949 (table 5).

Important points noted are:

1. Total personal income in 1964 almost tripled that of 1949.
2. Farm income decreased about half during this same period.
3. Transfer payments almost doubled from 1949 to 1964.
4. Per capita income has nearly tripled during this 15-year period.

County personal income increased about 17.8 percent from 1960 to 1964. The State increase in personal income for the same period of time was 18.6 percent. More than half the county families had incomes of under $3,000 annually while one-fourth of the State family incomes were under $3,000 annually.

Current Growth Characteristics

Among the current indicators of growth in this area are unemployment rate, average income, changes in total personal income, population, volume, and trend of bank transactions.

The unemployment rate for Rio Arriba County was about 15 percent in 1966, which is a lower rate than during the past few years. The average 1964 per capita income of $1,340 is more than double the 1954 per capita average income of $537. Personal income in 1964, $34,000,000, was almost 3 times as large as it was in 1954. The population of the county appears to have reached a low of about 24,000 during the early 1960's and now approaches 26,000 or more persons. The volume of banking transactions, number of deposits, and loans are increasing. In Espanola, the 1964 deposits totaled $11,299,832, whereas in 1965 deposits had increased to $11,606,959, a 3 percent increase (Albuquerque National Bank, 1966). Loans in Espanola for 1964 amounted to $6,119,194 and by 1965 had increased by almost 20 percent to $7,417,936.

Industrial and commercial firm employment increased from about 1,100 in the first quarter of 1956 to almost 1,500 the first quarter of 1964. Taxable payroll during this same period nearly doubled from $786,000 to $1,415,000 annually (U. S. Bureau of Census, 1964).

Table 5, Estimated personal income by major sources in Rio Arriba County, New Mexico, 1949-1964

	1949 1/	1954 1/	1959 1/	1964 2/
	(1,000's)			
Total	$13,251	$12,462	$20,926	$33,902
Wages & salaries	5,882	6,148	11,727	21,359
Other labor income	54	139	262	450
Proprietor income	3,427	2,165	3,654	2,390
Business & Professional	(1,500)	(1,332)	(2,275)	(1,485)
Farm	(1,927)	(833)	(1,379)	(905)
Property income	1,222	1,284	1,778	5,209
Transfer payments	2,713	2,910	3,800	5,396
Less: Social Insurance Contributions	- 47	- 184	- 295	- 902
Per capita income	$ 530	$ 537	$ 890	$ 1,340

1/ Income of Employment in New Mexico 1949-1959, New Mexico Studies in Business and Economics #8, 1961, Bureau of Business Research, University of New Mexico, Albuquerque, page 42, by Ralph L. Edgel and Vicente F. Ximimes.

2/ 1964 Income of Employment in New Mexico, 1960-1964, New Mexico Studies in Business and Economics #15, Bureau of Business Research, University of New Mexico, Albuquerque, page 35, by Ralph L. Edgel and Peter J. LaLonde.

Urban Centers and Their Influence

Espanola is by far the most influential community. It has recently made annexations, an earmark of growth, and will increase the associated service functions necessary such as fire protection, police protection,

water and sanitation services, traffic responsibilities, and street construction. As the community grows these associated services enhance the general economy.

Land Status and Land Use

Four major categories of land status are private, Federal, Indian, and State lands. The Federal lands are administered by the U. S. Forest Service and the Bureau of Land Management. The quantities are indicated in the following tabulations:

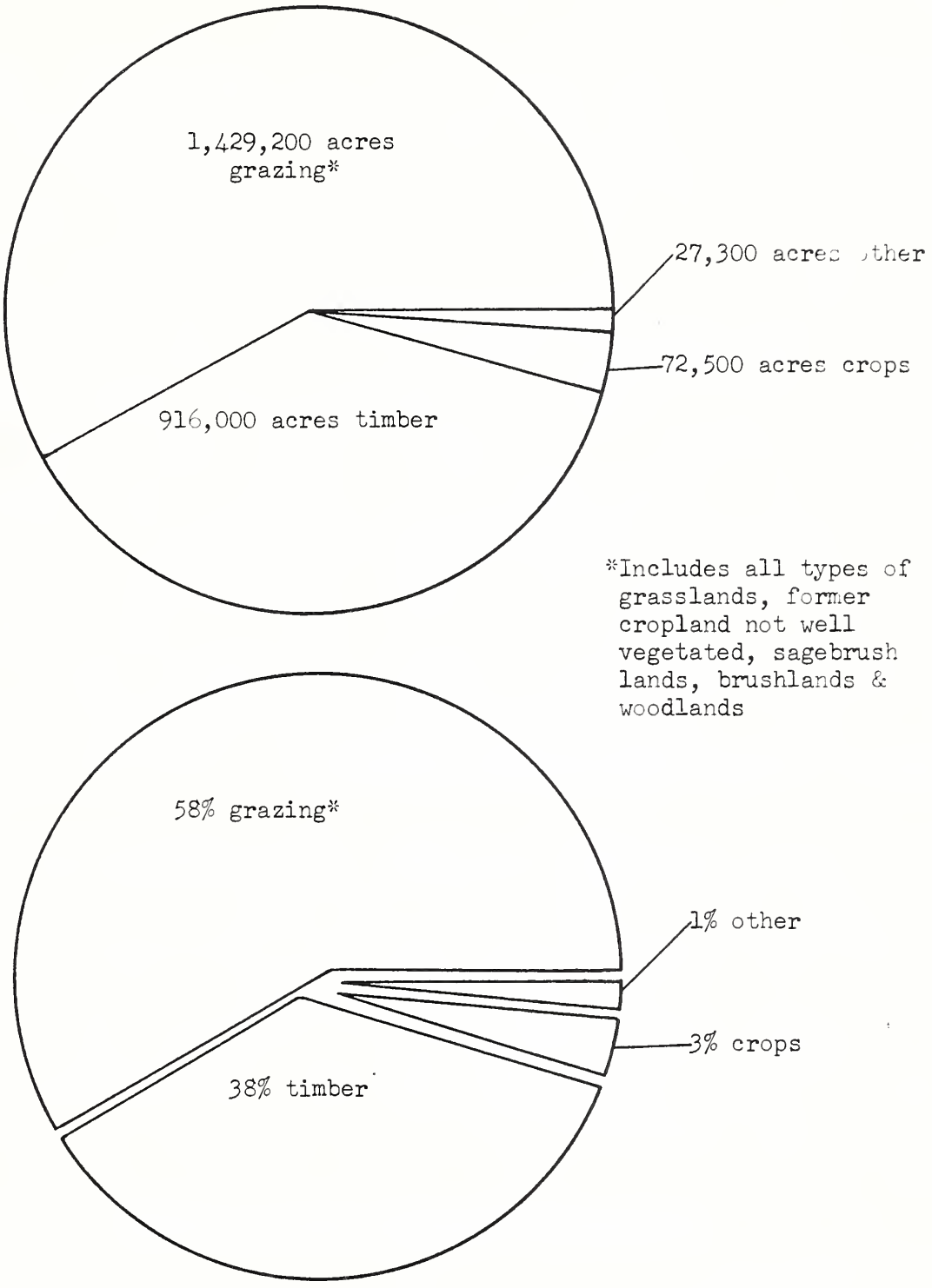
Table 6, Comparison of land status in Chama-Otowi Sub-Basin and in New Mexico, 1966

Status	Sub-Basin		New Mexico 1/	
	Acres	Percent	Acres	Percent
Federal	1,503,000	61	27,150,000	35
Indian	225,000	9	6,857,000	9
State	61,000	3	9,304,000	12
Private	656,000	27	34,456,000	44
Total	2,445,000	100	77,767,000	100

1/ Source: "Summary Reports on New Mexico's Resources" Phase I, State Resources Development Plan, an excerpt, Section VI: Land and Water, February 1966, State Planning Office, Santa Fe, New Mexico.

Of the total land area, cropland occupies 72,500 acres (or 3 percent of the total area). Nearly three-fifths of the cropland is irrigated and the remainder is non-irrigated.

The second land use is for commercial timber production, of which a large part is grazed. About 916,000 acres or 38 percent of the land is used for



*Includes all types of grasslands, former cropland not well vegetated, sagebrush lands, brushlands & woodlands

LAND USE
Chama-Otowi Sub-Basin
Upper Rio Grande Basin
New Mexico
January 1967

FIGURE 3

this purpose. About 27,300 acres are used in other ways (figure 3). About 1,429,000 acres is utilized only for grazing livestock. A large part of this grazing area is woodland.

Transportation

Three U. S. Highways crossing this sub-basin are U. S. Highways No. 64, 84, and 285. Highway 64 leads from Santa Fe, New Mexico, to Espanola then through Taos through Raton. U. S. Highway 84 crosses a major part of northern New Mexico from East Interstate 40 to Santa Fe, through Espanola and Chama, and into Pagosa Springs, Colorado. U. S. Highway 285 crosses the entire State from Carlsbad and Roswell in Southern New Mexico through Santa Fe and Espanola in Northern New Mexico, and continues through Antonito, Colorado. State improved and unimproved roads are State Highways 17, 29, 95, 96, 100, 110, 111, and 112.

The Denver and Rio Grande Western is the only operating railroad and it has no passenger service. A dirt landing strip (runway) is located at El Vado State Park. Chama has a proposal for an airport in the near future. Espanola's airport, 4,100 feet long, is a public facility. There are six runways suited for light planes only. A few private air-strips are located throughout the area.

Agriculture and Related Economic Activity

Major Crop Enterprises

Major crop enterprises are pasture, hay, and alfalfa which total about two-thirds of all cropland acres. These major crop enterprises are utilized in the livestock industry. The estimated irrigated cropland acres amounted to about 43,100 in 1960 of which about 8 percent or 3,500 acres

Photo
NM-P392-10

Alfalfa hay production in Espanola-Rio Chama Watershed northwest of Espanola

Photo

Good roads encourage economic development

Table 7, Acreage harvested by kinds of crops, Rio Arriba County, New Mexico 1949-1966

Year	Corn	Sorghums	Wheat	Oats	Barley	Dry Beans	Alfalfa 1/	Other Hay	Vegetables	Fruit
1949	3002	377	5933	1970	2060	1823	6258	9211	321	1604
1954	1340	23	5383	1304	1206	1416	8504	5719	249	1443
1959	644	6	2230	191	588	148	4174	6183	193	1249
1964	100	--	4200	200	400	100	4700	9500	190 2/	2030
1966 3/	450	--	3800	200	150	100	6000	4700	200 2/	2100 2/

1/ Includes alfalfa mixtures
2/ Estimated
3/ Preliminary
Source: Selected Statistics Relating to Agriculture in New Mexico, Research Report #21, March 1959, and New Mexico Agricultural Statistics, June 1966 and June 1967.

were idle or fallow. Orchards, small grains, corn, and vegetables are grown on about 25 percent of the acreage devoted to crops.

Drastic decreases in crop acreages of corn, sorghums, oats, barley, and dry beans occurred since 1949 (Table 7). Wheat and vegetable acreages decreased by modest amounts, while acreage of fruit actually increased substantially from a low of about 1,300 acres in 1959 to a high of almost 2,100 acres in 1964 and 1966. Alfalfa hay acreage was about the same in 1966 as in 1949 while other hay acreage harvested decreased about one-half.

Major Livestock Enterprises

Sheep and cattle are the two major livestock enterprises accounting for about 99 percent of the total value of livestock in Rio Arriba County in each of the years 1961 through 1967 (Table 8).

Table 8, Percentage of total livestock value on farms and ranches, Rio Arriba County, New Mexico, 1961-1967

Year	Cattle	Hogs	Sheep	Chickens	Total
1961	79.0	0.7	20.0	0.3	100.0
1962	84.3	0.7	14.7	0.3	100.0
1963	83.3	0.8	15.6	0.3	100.0
1964	81.7	0.6	17.5	0.2	100.0
1965	73.3	0.7	25.8	0.2	100.0
1966	70.5	0.3	29.0	0.2	100.0
1967	72.2	0.3	27.3	0.2	100.0

Source: New Mexico Agricultural Statistics 1962-1967
New Mexico Department of Agriculture and U. S. Department of Agriculture, Statistical Reporting Service

On January 1, 1967, there were about 26,000 head of cattle and calves, and about 67,000 sheep on farms in Rio Arriba County (Table 9). Hogs numbered 400 and chickens about 7,500. About 300 milk cows were included in this total number of cattle. Sheep and cattle are the two primary types of livestock. Cattle numbers have reached a high of 30,000 in 1962 and a low of 25,000 in 1966. During the period 1960-1967 sheep numbers increased from a low of 50,000 in 1961 to the current level of 67,000 in 1967 during this 8-year period.

Table 9, Number of livestock on farms and ranches, Rio Arriba County, New Mexico, January 1, 1960-1967

Year	Cattle 1/	Hogs	Sheep	Chickens	Total
1960	25,000	1,600	52,000	15,000	93,600
1961	29,000	1,600	20,000	14,000	94,600
1962	30,000	1,500	57,500	14,000	103,000
1963	29,000	1,600	56,000	12,000	98,600
1964	28,000	3,100	56,000	10,000	95,100
1965	26,000	1,100	63,000	8,000	98,100
1966	25,000	1,000	67,000	9,600	102,600
1967	26,000	400	67,000	7,500	100,900

1/ Includes milk cows.

Source: New Mexico Agricultural Statistics 1962-1967, New Mexico Department of Agriculture and U. S. Department of Agriculture Statistical Reporting Service.

Hog numbers declined drastically by about 75 percent from 1600 in 1963 to about 400 head in 1967. A 50 percent decrease in numbers of chickens from 15,000 in 1960 to 7,500 in 1967 indicates a relatively unimportant part of the total value of Rio Arriba County's total livestock inventory values. Several hundred horses are located in the county but have not been included in these livestock numbers or values.

Volume and Value of Farm Output

Principal crop farm values in Rio Arriba County, varied from a high of about $1,192,000 in 1961 to a low in 1965 of about $700,000. Hay and fruit values account for about 90 percent of the total crop values, while corn, wheat, small grains, and vegetables received the remaining 10 percent of the total value.

Table 10, Value of farm products sold, Rio Arriba County, New Mexico 1949 and 1964

	Value			
	1949		1964	
	dollars	percent	dollars	percent
All Farm Products	1,856,801	100	3,122,553	100
Average per farm	1,032	-	2,615	-
All crops sold	362,437	20	790,360	25
All livestock & livestock products	1,494,364	80	2,332,193	75

Source: U. S. Department of Commerce, Census of Agriculture, 1950 and 1964

The value of farm products sold in Rio Arriba County increased by more than $1,000,000 from 1949 to 1964 (Table 10).

Value of livestock and livestock products sold off farm and ranch amounted

to about 75 percent of all farm products sold and crops sold were valued at the remaining 25 percent in 1964.

Inventory values of livestock during the 8 years, 1960-1967, reached a low of $3,545,000 in 1965 and a high of $4,935,000 on January 1, 1967 (Table 11).

Table 11, Inventory value of livestock on farms and ranches, Rio Arriba County, New Mexico, 1961-1967

Year	cattle	hogs	sheep	chickens	total
	- - - - - - - - - - - -		(1,000 dollars)	- - - - - - - - - -	
1961	3,451	34	870	16	4,371
1962	4,020	35	702	15	4,772
1963	4,000	40	750	13	4,803
1964	3,500	22	751	10	4,283
1965	2,600	23	914	8	3,545
1966	3,175	14	1,308	8	4,505
1967	3,562	13	1,351	9	4,935

Source: New Mexico Agricultural Statistics 1963-1967

Employment and Income

Agricultural - There has been a gradual decline in the number of agricultural workers during the past few years. In 1961 about 1,300 persons were employed in agriculture in Rio Arriba County. The following year employment averaged about 1,000 and in 1963 declined to about 960 (New Mexico State Employment Service, 1965). About 23 percent of the total county employment was in agricultural pursuits and 77 percent engaged in non-agricultural work in 1963. County employment in agriculture

declined about one-third from 1960-1964.

Median family income from the rural farm sector in Rio Arriba County averaged about $3,800 in 1960 whereas the median family income from the urban center averagedabout $6,000 annually, almost 60 percent more than the rural farm sector.

Related Industries - About 230 persons were employed in related trade, service and processing industries in Rio Arriba County during 1960. (U. S. Bureau of Census, 1960). Included are three related industries: Forestry and fisheries; furniture, lumber, and wood products; manufacturing; and food and kindred products.

The number employed in forest industries ranged from about 220 in December 1963 to a high of 355 during July that same year.

Capital Investment

The average investment value per farm increased almost 8 times within the twenty years 1945-1964 (Table 12).

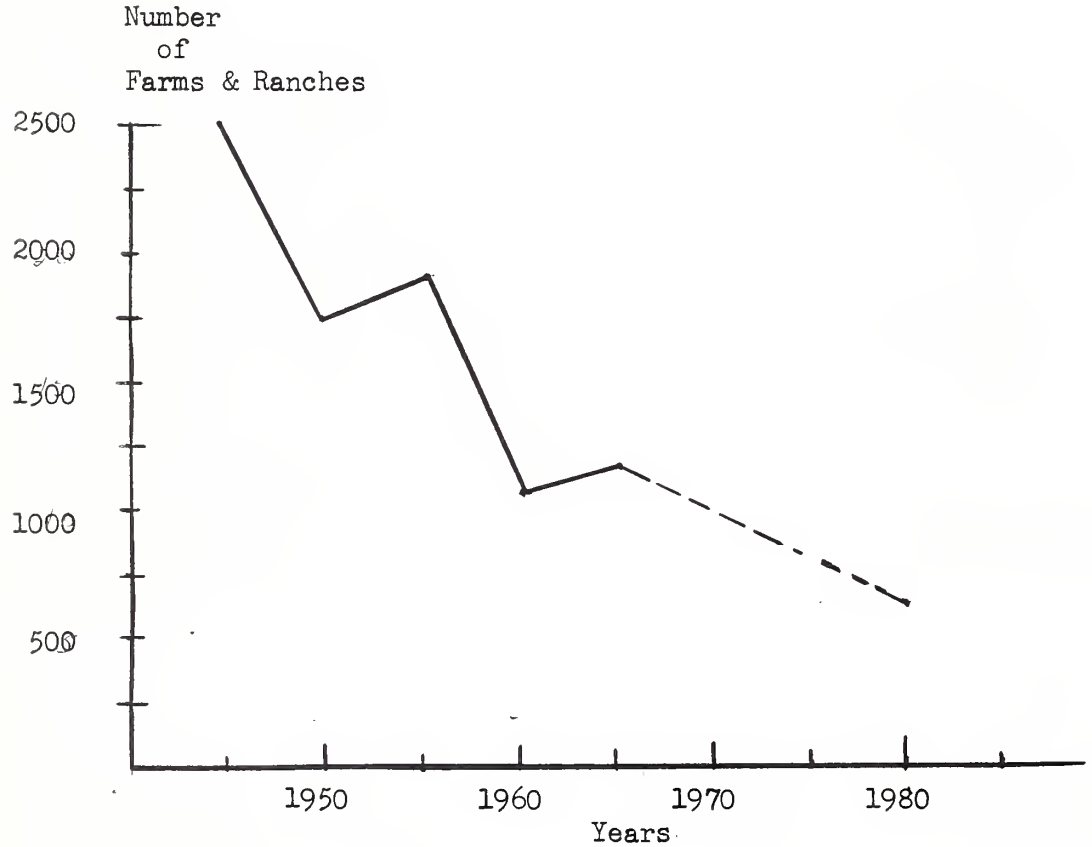
Table 12, Number, average size, and value of farms and ranches, Rio Arriba County, New Mexico 1945-1964

Year	Number of farms	Average size (acres)	Value of Land & Buildings	
			Average per farm	Average per acre
1945	2440	683	$ 4,752	$ 7
1950	1799	803	8,220	26
1954	1880	814	7,626	20
1959	1033	1353	20,641	20
1964	1194	1426	37,243	26
1970 1/	1000	1702	54,500	32
1980 1/	700	2432	102,100	42

Source: U. S. Department of Commerce, Census of Agriculture 1950-1964
1/ USDA Field Party estimates.

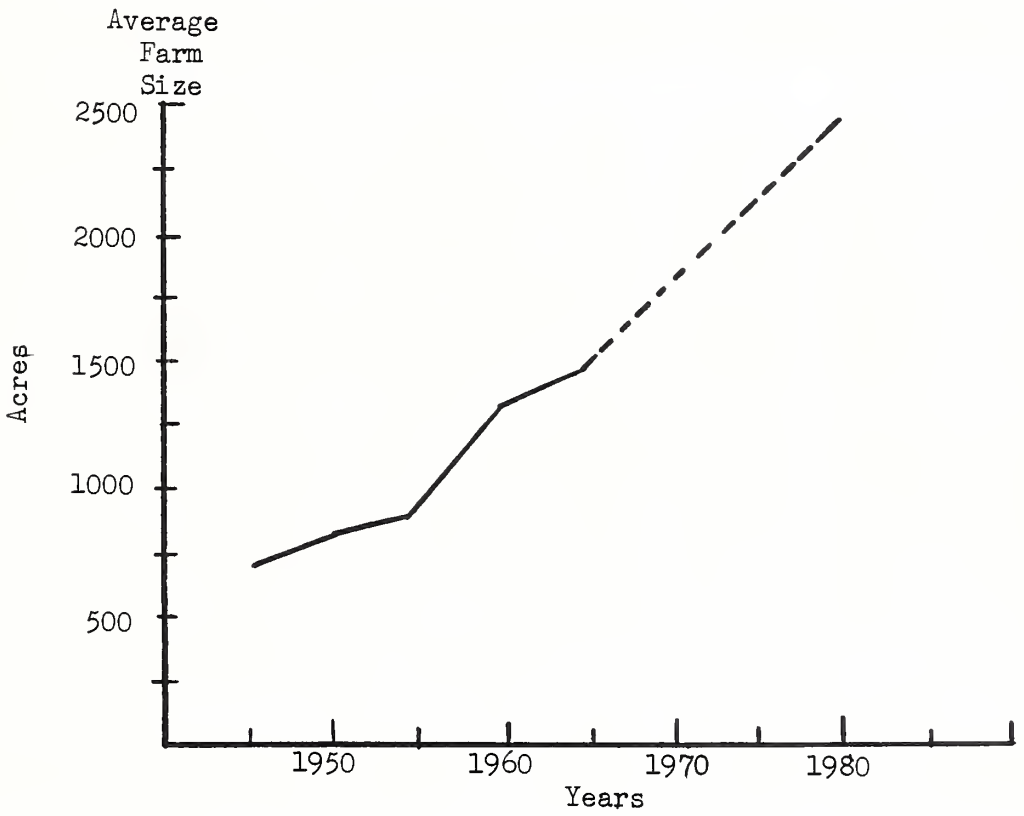
The average dollar value per farm increase, from $4,752 in 1945 to $37,243 in 1964, is significant and indicates the general trend toward fewer but larger farms. This trend is expected to continue for the next 10 to 15 years, with a probable significant increase in the average value per acre, estimated to reach $42 by 1980. Farm numbers are expected to decrease to about 700 (Figure 4) and farm size to increase to about 2400 acres by 1980 (Figure 5).

Figure 4, Number of farms and ranches in Rio Arriba County, New Mexico 1945-1980



Source: U. S. Department of Commerce, Census of Agriculture 1945-1964, Projections: USDA Field Party

Figure 5, Average farm size in Rio Arriba County, New Mexico 1945-1980



Source: U. S. Department of Commerce, Census of Agriculture, 1945-1964
Projections: USDA Field Party

In 1945 about 71 percent of the total farms were smaller than 50 acres in size (Table 13). Almost half of these were smaller than 10 acres. About three-fourths of all farms were smaller than 50 acres in 1954, while nearly one-half the farms were less than 10 acres in size. By 1964, only 30 percent of the farms were less than 10 acres, about 35 percent were 10 to 49 acres, and 29 percent were 100 acres or larger. There is a definite trend in fewer and larger farms in Rio Arriba County, especially fewer numbers in those farms of 100 acres or less in size.

Table 13, Number and percentage of farms and ranches by size groups in Rio Arriba County, New Mexico, 1945-1964

Year	Total number	Percent of farms in each group				
		Less than 10 acres	10-49 acres	50-99 acres	100-499 acres	500 acres or more
1945	2440	33	38	8	13	8
1950	1799	38	35	8	11	8
1954	1880	46	29	6	11	8
1959	1033	28	34	7	13	18
1964	1194	30	35	6	12	17
1970 1/	1000	28	32	7	13	20
1980 1/	700	25	27	7	16	25

1/ Estimated by USDA Field Party

Source: U. S. Department of Commerce, Census of Agriculture, 1950-1964

Forest Resources and Related Economic Activities

Extent and Nature of the Resource

The sub-basin is moderately wealthy in timber resources. The rate of harvest is expected to keep pace with the predicted increased demands for forest products.

The annual cut is 23.6 million board feet of lumber from the 669,600 acres of National Forest. This is within the allowable cut from the National Forests and amounts to about 71 percent of the total timber harvest. Approximately 25 percent of the timber harvest is on State and private lands. The remaining 4 percent is cut on the lands of the Jicarilla Apache Indians, (Table 14). The annual cut is less than the allowable under sustained yield management and could be increased if demand dictates.

Table 14, Average and allowable annual timber harvest, Chama-Otowi Sub-Basin, New Mexico, 1966

Location	Average cut (board ft.)	Allowable cut (board ft.)
Carson National Forest	5,200,000	16,200,000
Santa Fe National Forest	18,400,000	26,200,000
Jicarilla Indian Reservation	1,300,000	1,800,000
Private & State	8,500,000	2,000,000 1/

1/ Private lands being overcut.

An untapped forest resource is the round or pulpwood. A recent report (U. S. Forest Service) estimates that approximately 10.8 million cords of pulpwood are available in the study area which encompasses the Chama-Otowi sub-basin.

Table 15, Volume of pole timber (5-11" dbh) by specie and ownership

Ownership	Mixed conifer	Ponderosa pine	Aspen	Total
National Forest	703,440	1,553,650	84,840	2,341,930
State and private	390,000	452,720	125,600	968,320
Indian	-	66,490	-	66,490
Other Federal	-	14,715	-	14,715
Total	1,093,440	2,087,575	210,440	3,391,455

Source: Pulp and papermaking opportunities in Northern New Mexico; Cooperative study by the U. S. Forest Service, Bureau of Business Research, University of New Mexico and the New Mexico Department of State Forestry.

Utilization

The major portion of the forest product harvest is processed in the sub-basin or nearby. The finished product of sized and rough lumber is used in the construction industry. An estimated 10 percent of the harvest is utilized within the sub-basin, while the remaining is shipped out.

The annual average cut of 33.4 million board feet represents a value of $103,500 to the owners as standing timber.

Two-thirds of the commercial timber acreage is ponderosa pine, 30 percent is spruce-fir-mixed conifer, and 3 percent is aspen (Table 15a).

Table 15a, Commercial forest land area, Chama-Otowi sub-basin, New Mexico

Forest type	National Forest	State and private	Other Federal	Indian	Total
		Acres			
Mixed conifer	195,400	100,000	-	-	295,400
Ponderosa pine	443,900	156,110	3,270	66,490	669,770
Aspen	30,300	15,700	-	-	46,000
Total	669,600	272,810	3,270	66,490	1,011,170

Current and Projected Growth

The current growth of commercial timber is estimated to be slightly in excess of 8 cubic feet per acre per year (Choate, 1966, p. 27). It is estimated that the annual yield potential of growing stock volume is about 38 cubic feet per acre.

Employment and Income

Projections of employment in the timber industry and value of harvest for the State have been made to the year 1980 by the Bureau of Business Research. Based on this projection, employment and value of the harvest will increase in excess of twofold. The harvest of forest resources provides year-round employment for approximately 358 men. If the forest product harvesting and processing attained its potential growth, employment could approach 790. Income from employment of 358 men earning an average annual salary of $3900 would be almost $1,400,000. Lumber and primary processing mills have capital investments in buildings and equipment estimated at $2.5 million.

Outdoor Recreation

Outstanding natural resources are available and are utilized extensively for outdoor recreational purposes. Climate, mountains, natural beauty, fishing-hunting, camping areas, and historic sites are characteristics favorable for intensive use of the area for outdoor recreation. An estimated 1,500,000 acres of land, 4,000 surface acres of lakes, and 670 miles of stream are available for outdoor recreational purposes (Table 16).

Available outdoor recreation facilities are inadequate to meet present demands on the area.

The recreation use on visitor days in the Carson and Santa Fe National Forests in 1963 was 1,600,000. Projections for visitor days use in 1976 is 4,500,000 and in the year 2000 is 19,000,000 according to National Forest recreation surveys. About one-half of this recreation activity is expected to occur within the sub-basin.

Table 16, Number and area of selected outdoor recreation facilities, Rio Arriba County, New Mexico, 1965

Status	Land		Water surface		Streams	
	Acres	Number	Acres	Number	Miles	Number
State	33,217	2	3,500	1	14	1
Federal	1,390,324	-	40	18	390	35
Private	42,578	12	473	2	274	28
Total	1,466,119	14	4,013	21	678	64

Source: (State Planning Office) Comprehensive Plan for Outdoor Recreation, New Mexico 1965.
U. S. Forest Service Information 1966
Fishing Waters of New Mexico, Map by New Mexico Department of Game and Fish

Recreation map shows the location of existing and potential recreation sites within the sub-basin. (See Recreation Map, Appendix I).

As outdoor recreation activities increase there will be a positive relationship in related economic activity.

Analytical techniques of social scientists at the University of New Mexico and New Mexico State University are being used to estimate the full impact of increased recreation upon a community or the State (New Mexico University, 1966) and (Grey and Anderson, 1964).

Photo
NM-P534-14

Photo
NM-P-533-5

Climate, mountains, natural beauty are favorable for intensive use outdoor recreation

V

WATER AND RELATED LAND RESOURCE PROBLEMS

Erosion Damage

Approximately 4,500 acre-feet of soil is eroded each year. Erosion is due to a combination of physical factors such as soil characteristics, vegetative cover, slope, and precipitation. The present erosion rate is shown on the Present Erosion Status Map and the maximum erosion to be expected, if no management were practiced, is shown on the Erosion Hazard Map (Appendix I).

Gross erosion rates vary from less than 1 to more than 7 acre-feet per square mile annually. About 30 percent of all erosion occurs on Series B and rough broken land soils 1/ which make up about 5 percent of the area. Approximately 61 percent of all erosion occurs on the lower 6 watersheds, the El Rito, Vallecitos, Pojoaque, Sebastian Martin-Black Mesa, Espanola-Rio Chama, and Santa Cruz. (PL 566 project status and watershed location map, Appendix I).

Erosion reduces infiltration rates of the soil and recharge of groundwater aquifers. It also promotes invasion by weeds and undesirable plants which results in a non-beneficial use of water. It also causes an increase in surface water runoff and higher peak flows. Gullies lower the water table of adjacent lands.

1/ See Appendix I - Table of Soil Characteristics and Related Features

Photo
NM-P391-13

Erosion along Highway 84 south of Espanola, typical of erosion in the area

Photo
NM-P391-11

Erosion along Rio Grande and Dry River at Highway 84 and Pojoaque

Economic and social consequences of erosion are:

1. Loss of productive land
2. Decrease in efficiency of operations due to gullies
3. Reduced crop production
4. Reduced pounds of meat produced due to decrease in forage
5. Deterioration of land causing decline in incentive of owners to improve land
6. Decrease in monetary value of land
7. Reduction in wildlife harvest
8. Reduction in recreation activity
9. Increased costs of road maintenance and road construction

Flood Damages

Total average annual damage is estimated to be $682,000. It was determined that 35 percent of the damages are due to floodwater and 65 percent to sediment.

Sediment Damage

Sediment deposition damage occurs on 7,200 acres of land and is estimated to average $443,000 annually. Much of the sediment is deposited on agricultural land, in irrigation canals, along streams and arroyos and in reservoirs. An average of 6 highway culverts along arroyos are plugged with sediments each year in the Espanola-Rio Chama Watershed. When this occurs, there is an increased possibility of flooding and damage. Deposition in the channels reduces their capacity to carry floodwater so that overbank flooding becomes more frequent. Field investigations indicated 45 arroyos are losing capacity due to deposition of sediment. The agricultural land

adjacent to these arroyos is being damaged by deposited sediments.

There are 102 locations where irrigation canals have broken or are weakened due to floodwater and/or sediment deposition. Field examination indicates sediment damage or potential damage from breaks in these canals will affect agricultural areas. These areas include an estimated 200 to 400 acres that will eventually lose their productive capacity.

Sediment deposition in the Rio Grande, Rio Chama, and Rio Ojo Caliente is causing a rising water table under many land areas adjacent to the river. This is a continuing process and has caused some farmland to become too wet to farm. In turn such lands become water-using phreatophyte areas. This is especially true in the San Juan Pueblo area and the Espanola-Rio Chama, Sebastian Martin-Black Mesa, Santa Cruz, and Pojoaque Creek Watersheds.

Suspended load samples taken from the Rio Chama during the irrigation season of 1964 showed sediment concentration as high as 58,500 parts per million. The silt-laden water is diverted from the Rio Chama and sediment is deposited in canals and on irrigated land. Some of this sediment is returned to the river and transported downstream. It is estimated that 90 to 95 percent of the sediment reaching the Rio Chama will be transported and deposited in Cochiti Reservoir. Although Cochiti Reservoir is designed to store the transported sediment, enroute it is damaging to fish and to the aesthetic value of clean, clear water. High concentrations of sediment in river waters contribute to the water quality problem.

Floodwater Damage

The total average annual direct floodwater damage is estimated to be $239,000 and involves 4,800 acres. Approximately one-half of the floodwater damages are due to interruption of irrigation water service resulting from destruction of or damage to irrigation facilities. Other floodwater damages to agriculture occur to crops, pasture, property, and forests. Non-agricultural damage occurs to urban property, roads, and bridges.

Most of this damage occurs during the months of June through September when local high intensity thunderstorms occur.

Four watersheds (Sebastian Martin-Black Mesa, Espanola-Rio Chama, Santa Cruz, and the Pojoaque) receive 90 percent of the floodwater damage. There is only minor floodwater damage above El Vado Reservoir on the Rio Chama.

Impaired Drainage

About 13,000 acres of irrigated land are affected by high water tables and salt accumulations that restrict crop growth and aid the spread of undesirable phreatophytes. About 16 percent of this acreage is severely affected, 30 percent moderately affected, and 54 percent is slightly affected. There are three major causes of these high water tables:

1. Sediments deposited in the river bed raises the water level in some areas.
2. Seepage loss from canals and laterals, in some instances as high as 20 percent per mile, occurs in areas where the

canals pass through sandy and gravelly soils.

3. Often irrigation water is applied more frequently and in larger amounts than is needed to supply the crop demand. The excess water further raises the water table.

The water table level fluctuates from season to season and is nearest the ground surface during the time of peak river flow and heaviest irrigation from May through August. In the Lyden area floodwaters pond on agricultural lands. This is caused primarily from lack of maintenance of a system of surface drains that was established about 30 years ago.

Water Supply and Limitations

Wet and dry cycles are characteristic of this area. Prior to 1946 precipitation and runoff were generally above the long-term average. Since then both precipitation and runoff have been below the long-term average.

"Since 1921-24 the 20-year average annual precipitation in Arizona and Western New Mexico has decreased by about 25 percent with the sharpest drops occurring in the northern half of the region." (Sellers) The period 1945 to 1960 is the longest dry cycle since precipitation records have been kept, starting late in the 1800's.

About two-thirds of the precipitation falls as torrential rainstorms in late summer. The rest occurs as snow or light spring and summer showers. Much of the light precipitation is lost through evaporation as droplets rest on vegetation canopy.

Two photos taken 30 years apart reveal (1) a 25 percent increase in canopy exposure (more foliage exposed to sunrays, greater area

Comparison study of Pinyon-juniper density increase over thirty-year period

Photo

1936 photo - note bare areas on hill in background and height of nearby trees

Photo
NM-P417-10

1967 photo - pinyon-juniper density has increased on hill in the background and nearby trees are taller. Photos taken near Santa Fe, New Mexico

transpiring water, greater area catching and holding precipitation) and (2) a 12 percent increase in actual ground cover (increase in shade, decrease in areas for grass growth, decrease in ground area for water absorption).

This constant increase in brush and woodland density makes this loss of moisture an increasing problem.

There are two general types of water problems for agricultural uses: (1) An actual lack of sustained late-season streamflow, and (2) the inability of delivering water through canal systems due to flood damages.

Surface waters are fully appropriated, consequently no new depletions of existing supply is permitted. Inadequate streamflows create problems in irrigated areas such as Tierra Amarilla, Canjilon, Coyote, and El Rito. A typical example of streamflow and irrigation water requirements in the tributary areas is shown in Figure 1. In some cases the average annual runoff of these tributaries is large enough to meet irrigation needs but downstream rights which cannot be impaired and provisions of the Rio Grande Compact make streamflow regulation impossible or impractical.

The lack of adequate facilities for livestock water creates problems in obtaining proper range use and management.

As demands for water to meet municipal, industrial, and recreation needs increase, the problems of obtaining the water and the works required to assure a firm supply will increase.

Phreatophytes

Phreatophytes are water-loving plants ranging from grasses to salt cedar (tamarisk) and cottonwood trees. Phreatophytes occur in all

regions of the United States but they cause the greatest problem in areas of limited water supplies in the Southwest (Blaney, 1961). These plants spread rapidly and consume large quantities of water that could be put to more beneficial use. In addition to depleting water supplies, they cause other problems such as accumulation of sediment, constriction of stream channels thereby increasing flood hazards and destroying beneficial vegetation. Salt cedar and cottonwoods use from 50 to 100 percent more water than most agricultural crops.

The total area occupied by phreatophytes is approximately 12,200 acres (Table 17). It is estimated that phreatophytes used 50,600 acre-feet of water in 1966.

The New Mexico Plateaus and Mesas Land Reource Area contains more than half of all the sub-basin phreatophytes. From Velarde to the Otowi gage on the Rio Grande and from Abiquiu to San Juan Pueblo on the Rio Chama more than 6,800 acres of non-beneficial woody phreatophytes are growing.

Photos taken in 1936 were compared to 1967 photos of this area. Phreatophyte acreages appear to be about double over that 31-year period and the plant density also appears to be greater due to a lack of positive phreatophyte control activity.

Range and Forest Fires

Fire is a constant threat though not to be considered a serious threat. The U. S. Forest Service records no fires of significance as having occurred in the sub-basin in the immediate past. There is however, physical evidence of a devastating fire having occurred in the high

photo

1936 photo from technical report on "Soil and Erosion Survey" San Juan Pueblo Grant

photo

1967 shot taken of identical area to compare with photo in 1936 - note increase in phreatophytes.

Table 17 - Estimates of annual water consumption by phreatophytes and potential savings, Chama-Otowi Sub-Basin, New Mexico 1966

Vegetative Type	Acres	C. U. 1/ ac.ft./yr.	Annual use ac. ft.	Potential savings 2/ ac.ft./yr.
NEW MEXICO PLATEAUS AND MESAS LAND RESOURCE AREA				
Russian Olive	2,380	4.9	11,662	5,665
Willow	1,700	4.4	7,480	3,324
Cottonwood	1,360	4.9	6,664	3,237
Juniper	340	4.4	1,496	665
Salt Cedar	136	4.4	598	265
Apache Plume	68	2.9	197	47
Big Sage	68	2.9	197	47
Miscellaneous	448	4.1	1,837	758
Grass	300	2.1	630	-
SOUTHERN ROCKY MOUNTAINS LAND RESOURCE AREA				
Willow	2,000	3.5	7,000	3,910
Cottonwood	650	3.8	2,470	1,516
Miscellaneous	405	3.2	1,296	- 689
HIGH INTERMOUNTAIN VALLEYS LAND RESOURCE AREA				
Willow	1,240	3.8	4,712	2,003
Cottonwood	700	4.2	2,940	1,369
Miscellaneous	405	3.5	1,418	552
Total	12,200		50,600	24,000

1/ Estimate of consumptive use values are based on U. S. Geologic Survey Water Supply Paper 1423 - "Phreatophytes", T. W. Robinson, 1958, and Consumptive Use and Water Requirements in New Mexico, Technical Report No. 32, Blaney and Hanson. Values are adapted to this area.

2/ This value of potential water saving computed for the area assuming that phreatophytes could be controlled during the early action program period could yield an annual savings of the amount of water shown.

country on the eastern boundary of the sub-basin and extending a considerable distance south from near the State line probably as far south as Vallecitos and El Rito.

Water Quality

In New Mexico one of the principal problems of water quality is that associated with land erosion. (New Mexico Water Quality Control Commission, 1967).

Heavy concentration (up to 58,500 ppm) of sediment in the Rio Grande and Rio Chama is a major problem. Major sediment contributing areas are shown on the Erosion Status Map (Appendix I).

The high concentration of sediments are undesirable in domestic and industrial supplies and the cost of removing the sediment from raw river waters may exceed all other costs in making the water suitable for use.

Concentrations of more than 3,000 ppm are considered dangerous to fish if sustained for a period of 10 days or more (Kemp, 1949). Concentrations of this intensity and extent are a yearly occurrence on the Rio Chama and Rio Grande. This is a real damage to recreation. In some cases sediment laden irrigation waters reduce yields of crops.

Inadequate sewage disposal systems are contributing to water pollution. Only 14 communities have community water systems and only Abiquiu and Espanola have complete community sewage disposal systems. Treated effluent from Chama empties into the Rio Chama, and from Espanola

into the Rio Grande. Fifty-eight of the 60 communities rely on privies, cesspools, and septic tanks for disposal of home wastes.

Many of the arroyos emptying into the Rio Chama and Rio Grande are used as public dumps for disposal of all types of waste. Much of this material is carried into the Rio Grande by flood flows.

Unemployment and Welfare

A high rate of unemployment and people on public welfare is a major problem. The unemployment rate was about 15 percent in Rio Arriba County in 1965. It has reached 25 percent within the past few years compared to about 6 percent for New Mexico. Recently total persons available for employment in Rio Arriba County averaged about 5,500 according to the Employment Security Commission. At a rate of 15 percent, about 800 persons were unemployed; at a 25 percent rate about 1,400 persons were unemployed.

Rio Arriba County ranked fourth in per capita welfare payments received in January 1965 in the State. In June 1964 the per capita payments, not including costs of medical care and special benefits, averaged $4.60 per inhabitant for the county compared to only $1.81 for the State. The case load was 1,546 and total disbursements (again, excluding medical and special-services costs) reached in excess of $116,000 total welfare payments in June 1964. The per-capita figures and the proportion of the population dependent upon such aid are perhaps the most significant among all these welfare statistics. Therefore, the fiscal year 1964 payments equal to $72.12 for each inhabitant and the June 1964 dependency rate of 11.8 percent for Rio Arriba are the most significant. Comparable state figures are $26.72 and 4.4 percent (Meaders, 1965).

Land Titles

Many problems in northern New Mexico are connected with clouded land titles. In many areas, because of these uncertain titles, the land cannot be used as collateral for credit, land values are very low, and the tax base is affected. Also conflicts about titles have hampered the issuance of a marketable title to many parcels of land.

VI

PRESENT AND FUTURE NEEDS

In this report "need" is defined as "something useful, required or desired that is lacking". This may include activities designed

1. To increase crop and livestock production, water yields, employment opportunities and/or
2. To reduce erosion, water losses, flood hazards, fire hazards, and/or
3. To improve the quality of crops, water, timber, educational levels, standards of living, recreational opportunities, and fish and wildlife habitat.

Watershed Protection and Management

All of the watersheds in the study area need some measure of protection and management. Principal management practices are deferred grazing and range proper use. Vegetation manipulation such as brush clearing and pinyon-juniper control are needed in eighteen of the watersheds. Several in Land Resource Area 36 need erosion control practices involving gully plugs, small debris basins, brush removal, and reseeding to grass.

The mixed conifer forests need management for timber stand improvement and increased water yield potential. Treatment includes thinning, pruning, strip and block harvesting, erosion control, and reseeding to grass.

Flood Prevention

A combination of measures needs to be developed and applied to the land to reduce damages. Needed structural measures include:

1. Construction of floodwater retarding dams, debris basins, and grade stabilization structures.
2. Construction of adequate channels from the arroyo mouth to the river to carry floodwater across damage areas.
3. Reorganization of ditch and canal systems with installation of adequate structures at arroyo crossings.
4. Channel improvement on the main streams.

Land Stabilization

An area of nearly 1,000,000 acres needs treatment to reduce severe erosion and excessive water runoff. About 300,000 acres need improved range management practices to cope with slight erosion and runoff. A vegetation management practice is needed to cushion the impact of erosion-inducing rainstorms and to slow down the runoff. The land treatment measures listed in Table 20 will promote effective land stabilization.

Drainage Improvement

The high water table problem on approximately 13,000 acres of irrigated lands needs to be corrected. The lowering of the water table by subsurface drainage will permit the land to be returned to full production of potentially high-value crops.

Consolidation of diversion dams and irrigation systems is needed to help prevent aggradation of stream beds. Channeling the Rio Grande is needed to aid in lowering the water table on adjacent lands. Drainage systems to the river in the Lyden area are needed to reduce floodwater ponding and to aid in lowering the high water table. Adequate arroyo channels to

the river would protect poorly drained areas from flood and sediment damage.

Irrigation

There is an immediate need to utilize in the most economical manner the existing water supply of the area by initiating water conservation practices on farm lands.

Photo NM-P-166-16

Rock and brush dam used by landowners under the El Guigue community irrigation ditch

Generally the major need for irrigation water development is seasonal regulation of streamflows. Consolidation and elimination of makeshift diversion dams and paralleling ditches would provide more efficient diversion and delivery of available water.

Water Needs for Land Suitable for Irrigation

There are about 200,000 acres of irrigable land in this sub-basin. The feasibility of utilizing this land is dependent upon the demand for crops that could be produced and the availability of water for irrigating these crops. Assuming that 2.5 acre feet per acre will be required at the point of use, a delivery requirement of 500,000 acre feet of water annually will be created.

Livestock Water Supply

The primary need for livestock water is proper distribution of watering facilities to permit more efficient use of rangeland. Present livestock water consumption of about 700 acre-feet per year is expected to remain about the same for the next 10 to 15 years.

Municipal, Domestic, and Industrial Water Supply

Several rural communites need a domestic water supply adequate to meet their present requirements. Adequate sewage disposal systems are needed in communities throughout the area. Current household water consumption is estimated to be 2,100 acre-feet per year. By 1980 this estimated use will increase to about 3,000 acre-feet annually.

At the present time industrial consumption of water is insignificant. Water needed for municipal and industrial dvelopments will have to be obtained by purchasing and retiring existing water rights or by offsetting their depletions with imported water.

Recreation

Adequate recreation areas to satisfy growing needs is a desirable public goal. These needs may be satisfied by both private and public development.

New Mexico recreation needs have been set forth in the New Mexico Recreation Development Plan. A minimum of 48 acres of general recreation area for every 1,000 persons within a one-half to two-hour driving time of each population center is recommended.

There are about 2,400 family units [1] in New Mexico, and there is a need for 11,400 family units. This represents a current deficit of about 9,000 family units for the entire State. An estimated 150 family units exist within Rio Arriba County while 200 family units are needed to meet minimum recommendations. These additional units would require about 220 acres minimum, (Herkenhoff and Associates, 1964). An estimated 15 percent or 1,340 units of the State deficiency are needed in the sub-basin and will require about 5,300 acres. Other recreational needs may include stream improvement, more campsites and trails for hikers and riders, other ski areas, and more small ponds and lakes.

Fish and Wildlife

Increased requirements for fishing and hunting facilities are projected by sale of licenses which is expected to increase gradually as population increases. (Kirkpatrick, 1965). Projections for the next 10 years, 1965 through 1975, show that the number of licenses for general hunting and fishing is expected to remain at a constant 1.3 percent of residents while the percentage of bird hunters is expected to decrease slightly during this period from 0.9 percent to 0.8 percent. Fishing is currently the most popular activity with an estimated 114,000 resident license holders and is expected to increase by 65 percent reaching about 192,000 licensees by 1975.

1/ Family unit is one table, one fireplace, one space for tent or trailer, and related facilities.

The number of general hunting and fishing resident license holders almost doubled from 1950 to 1964, while licenses for big-game more than doubled during this same period. Non-resident licenses for fishing and hunting increased by about 50 percent over the same time period.

Projections of annual sales of licenses to New Mexico residents show a gradual increase in the percentage of total license holders. Therefore, a continued increase is expected in the need for substantial amounts of water and related land to provide fish and game habitat.

Water Quality Control

Designated garbage and trash disposal areas which cannot contribute to stream pollution are needed. Enforcement of State or county laws are, and will be, necessary to control garbage and trash dumping into arroyos. Community water and sewage systems are needed to reduce pollution of the Rio Chama and Rio Grande. Sediment control measures will be needed to reduce the amount of sediment reaching the streams.

Rural Power Supply

Electricity to rural areas is supplied primarily by three electric cooperatives. These cooperatives get their power wholesale from the Plains Electric Generation and Transmission Company, Inc. of Albuquerque. Total sales to two of the major cooperatives increased from 9,709,811 kilowatt hours in 1955 to 23,613,599 kilowatt hours in 1963. Past trends by the power company and by REA (Rural Electric Association) members indicate they have been doubling their capacity every 7 years. Based on this information, electric power requirements are estimated to increase about 2½ times from 1965 to 1980. (Table 18)

Table 18, Estimated electric power requirements, Chama-Otowi Sub-Basin, New Mexico

Year	Number of meters	Average annual use per meter (kwh)	Total power needs (kwh)
1960	8,600	3,084	26,500,000
1965	10,500	5,833	61,200,000
1970 1/	14,600	6,176	90,200,000
1980 1/	20,300	7,080	143,700,000

Source: Based on information from electric cooperatives.
1/ Estimated by USDA field party.

Photo NM P392-4

Jemez Mountain Electric Cooperative northwest of Espanola

Marketing

Markets for all agricultural products (crops, livestock, and forest products) need establishing or improving. Much of the current production can be marketed locally but local markets cannot take all the current production or any increased production.

Some crops such as fruit and hay are moving into regional and out-of-state markets. Some livestock and livestock products such as cattle, sheep, and wool are sold locally for shipment out of the area and processed at distant points. These market outlets could be improved and management techniques could be recommended for the future. Vegetables for the fresh or frozen market could be produced if the proper market outlets could be established.

Social Needs

Training to develop employee skills and employment opportunities appears to be a significant need. Additional training programs, technical training centers, and additional industry are needed to assist in reducing unemployment. Efforts should be directed at training unskilled laborers, providing employment opportunities in the 29-40 year age group, and directing persons into areas where there are current labor shortages or where potential shortages may develop.

Another need exists for reducing the number of welfare recipients by reducing the need for welfare. This could be aided in part by hiring welfare recipients part-time, and by training dependent children as they approach employment age, allowing them to work at jobs which could be done within the home, or similar activities.

Legislation to permit welfare recipients to earn additional money without loss of eligibility for welfare payments or to provide partial welfare payments to needy workers could be an incentive for people to seek employment.

A means to clarify land titles in the area is urgently needed. Lack of a clear title is a hindrance to sale of land and prevents the land from being used as collateral. It also keeps many land values lowered, affecting the tax base.

VII

EXISTING WATER AND RELATED LAND RESOURCE PROJECTS AND PROGRAMS

Agencies of the Departments of Agriculture, Interior, and Army have existing projects and programs which are designed to meet some of the needs for conservation and utilization of water and land resources.

PL 566 Projects

Santa Cruz Watershed

The Pojoaque and Espanola Valley Soil and Water Conservation Districts planned and completed structural measures for watershed protection and flood prevention for the Santa Cruz Watershed with assistance from the Soil Conservation Service, Forest Service, and Bureau of Land Management. Six floodwater retarding structures, three debris basins, and 1150 feet of diversions were constructed. The six retarding structures have an aggregate capacity of 1,702 acre feet for floodwater detention and sediment storage. Land treatment for this watershed includes proper management, seeding, fencing, timber management, brush control, spring development, erosion control structures, roadside erosion control, pitting, ranch ponds, and trail rehabilitation. An estimated 30 to 50 percent of the land treatment measures have been installed on private lands. To date the project has been effective in materially reducing flood and sediment damage in the project area.

Other Department of Agriculture Programs

Soil Conservation Service, PL 46

The 74th Congress enacted Public Law 46 establishing a national soil and water conservation policy creating the Soil Conservation Service. It

Photo

Site #5, Santa Cruz River Watershed project, 4 miles northeast of Espanola

Photo ORC-39-12

Concrete-lined ditch replacing earth ditch

directed the Soil Conservation Service to develop a program to produce results in preventing soil and water wastage and in reducing flooding and sediment hazards. To effectively carry out this responsibility, technical services are available to landowners in organized Soil and Water Conservation Districts to assist in planning, designing, and applying conservation practices. These services include soil surveys, where the soils are classified to better determine the capability and best use of the land; conservation planning where the landowner is assisted in developing a plan to effectively evaluate needed conservation and plan a course of application; engineering and geologic services are available to investigate, design, and assist in construction of structural measures in carrying out the needed conservation measures as planned by the landowner; other technical services such as agronomy, biology, range management, and recreation are also available to assist landowners.

Resource Conservation and Development

The Northern Rio Grande Resource Conservation and Development Project was initiated in 1964 as part of Rural Areas Development. All of the sub-basin is in the RC&D project area.

The primary objective of the plan is to propose action for the development, conservation, and utilization of the area's natural resources, thereby increasing income and expanding the employment and other economic opportunities for the people. At the time the RC&D plan was approved in October, 1964, over 100 project measures had been proposed and 83 other proposals have been made since then. These project measures include reorganization of irrigation systems, improved water and range management, tree planting, timber stand improvements, expanded harvesting and processing of forest

products, and development of recreation facilities. Construction work on 34 water projects had been completed, or was underway, by June 1967. The initial phase of reorganization and construction has been completed on twelve community ditch systems. These improvements include one diversion dam on the Santa Cruz River, 80 small water control structure, 6.3 miles of concrete ditch lining, and 0.35 miles of irrigation pipeline. Three of the twelve systems with the initial construction completed are continuing the improvement according to plans. Five other projects are under construction.

Agricultural Conservation Program

The Agricultural Conservation Program administered by the Agricultural Stabilization and Conservation Service is the program through which the United States Department of Agriculture provides a cost share for landowners and operators to install conservation practices that are difficult and expensive, but which have enduring benefits to the local economy, and which probably would not be installed if cost-sharing were unavailable.

Available programs include practices for establishment of permanent protective cover, for improvement and protection of established vegetative cover, for the conservation and disposal of water, and for wildlife conservation with soil and water conservation benefits. The cost-share rate for most practices is fifty percent of the cost for materials and installation. For wildlife and forestry practices, the cost-share rate is eighty percent of the cost. An individual farmer or rancher whose annual income is less than $3,000 is eligible for an eighty percent cost share on all individual practices for which cost share is available.

An "Acequia" or community irrigation ditch system is able to apply for a pooling agreement for two practices: reorganizing irrigation systems and lining irrigation ditches. Where the "ACP" may provide up to 70 percent of the cost, the State of New Mexico may provide an additional 15 percent of the cost. The cost to the "Acequia" system for such projects is the remaining 15 percent.

Farmers' Home Administration

The Farmers' Home Administration is a lending agency of the United States Department of Agriculture for providing credit and management aid to people in rural areas. Loan programs available to farmers who are unable to obtain loans from private sources are: (1) Farm ownership loans enable farmers to develop and enlarge existing farms. (2) Farm operating loans are designed to aid farmers in purchase of livestock and create operating capital for the year. (3) Housing loans are made to farmers and dwellers in small urban areas for modest-sized homes. (4) Under the provisions of Title III, Economic Opportunity Act of 1964, FHA is given broad directives to provide assistance in the fight against rural poverty. Loans up to $2500 may be made for establishing profit-making enterprises. (5) Soil and water development loans are available to farmers who wish to improve their land or their water facilities, both domestic and irrigation. Under this same program groups of farmers or urban dwellers may form an association and obtain loans for development of water and sewer facilities. The towns of Chama and Hernandez now have loans for this type of development. (6) Recreation development loans. FHA also has facilities to aid groups of ranchers enlarge their grazing holdings by loans to grazing associations. The loans are used to purchase desirable grazing tracts or to buy grazing leases. (7) FHA is authorized to make

loans or advancements to local organizations to finance the local share of costs of carrying our PL 566 works of improvement.

Cooperative State-Federal Forestry Programs

The U. S. Forest Service and the New Mexico State Forestry Department are involved in three State-Federal Cooperative Forestry Programs: (1) fire control, (2) forest management, and (3) tree planting. The New Mexico State Forestry Department is providing fire protection on State and private lands in the State. The U. S. Forest Service provides fire protection for State and private lands inside the National Forest boundaries. It may provide fire protection for private and State land adjoining the National Forest boundaries.

The objectives of the State forest management program are to place the small private woodlands under good forestry management and to work with primary processors of timber products to eliminate waste and improve the quality of wood products. The New Mexico State Forestry Department has five District Foresters throughout the State to assist, on request, private landowners in management of these woodlands. They also assist processors of wood products. In a typical year assistance is provided on fifty requests with the following results:
(1) 160 acres of timber stand improvement, (2) 143,000 acres placed under fire protection, (3) about 5.8 million board feet of timber harvested from about 9,000 acres, (4) harvested $6,400 worth of special forest products, and (5) returns from grazing about $46,000.

The tree planting program is designed to supply private landowners with suitable tree stock and seed. The program provides planting stock for establishing windbreaks, shelterbelts, forest plantings, for cropland conversion, flood control, and other similar projects.

National Forest Development and Multiple-Use Programs

National Forests are managed under principles of multiple use to produce sustained yield of products and services. These principles of management were strengthened by the Multiple Use Act of June 12, 1960. These principles provide for the management of forest resources so that they are utilized to best meet the needs of the American people. These forest resources are water, timber, range, recreation, and wildlife habitat.

Water Resources

As regulators of water flows, National Forest watersheds are managed in accord with two principal objectives: (a) protection of the watershed by stabilizing the soil, thereby preserving and improving water quality; and (b) management to increase the quantity of water.

The program of watershed management, rehabilitation, and protection of the hydrologic condition of the watersheds includes:

1. Complete soil survey of National Forest lands.
2. Stabilization of 690 miles of gullies, 67 miles of streambanks, and 282 miles of abandoned roads and trails.
3. Maintain and prepare watershed management plans for areas that are the major source of municipal water supplies.
4. Sheet erosion control on 113,200 acres.
5. Installation of 54 sediment control basins.

Timber stand improvement (thinning to increase growth and water utilization

Increase in increment (growth) through release of competition

6. Installation of 88 miles of snow fence to increase snow pack depth and prolong the runoff period.
7. Vegetation type conversion of 27,200 acres and removal of 300 acres of riparian vegetation to increase water yield.

Timber Resources

The goal for the National Forest system is an annual harvest on a sustained yield basis to meet the projected need for timber which the National Forests can be expected to supply. This goal is being accomplished by (a) intensifying the management of existing stands, (b) reforestation and afforestation of 19,100 acres, (c) timber stand improvement on 91,700 acres of commercial timber, (d) reduce timber losses from disease and insects, (e) fire control measures to reduce fire hazard on 53,200 acres of commercial timber.

Range Resources

Two objectives in the development and management of the National Forest rangelands are: (a) intensive management to preserve areas with satisfactory conditions; and (b) improvement measures to areas having unsatisfactory conditions. Progress toward these objectives are being made by the following program proposals:

1. Complete and keep current range inventories and management plans for all allotments.
2. Make necessary stocking adjustments as rapidly as practicable.
3. Properly coordinate all range use with other resource use.
4. Control noxious or poisonous plants and revegetate ranges on 30,800 acres.

5. Construct fences and watering facilities including 80 spring developments, 25 wells, 63 earth reservoirs, 12 "trick tanks" and 4 pit tanks complemented by 462 miles of fence.

Recreation Resources

The projected growth of the Nation will add to the already intense use of the National Forest recreational facilities. To meet the predicted demands in kind and quality, 193 new sites on 4,202 acres are being developed in the National Forests.

Wildlife Habitat Resources

National Forest visits by hunters and fishermen account for about one-quarter of the total recreation visits. The objective of habitat management is to make it fully productive for the support of fish and game populations and to contribute to public use and enjoyment.

Wildlife habitat management proposals being carried out are:

1. Devise and complete management plans for all administrative units.
2. Develop wildlife openings, food patches, game ways in dense vegetation, and install six wildlife watering facilities.
3. Improve 50 additional miles of fishing streams by stabilizing banks, planting streamside cover, and constructing channel improvements.
4. Make available 16 surface acres of new lakes.

Photo
NM P392-8

Temporary water storage in Abiquiu Reservoir

Reservoir or Local Protection Projects

Corps of Engineer Projects

Abiquiu Dam and reservoir, located about 20 miles upstream from Espanola on the Rio Chama has been operated for flood control and sediment retention since February 1963. The reservoir has a capacity of 1,225,400 acre feet at spillway crest with about 502,000 acre-feet of capacity reserved for flood control and 77,000 acre-feet for sediment retention and the remaining capacity is for protection of the spillway. Limited recreational facilities have been developed on the north side of the reservoir. Construction of emergency bank protection consisting of structural steel jetties, channel snagging and clearing, and some channel straightening on the Rio Grande in the Espanola and Velarde area was completed in 1952 and 1953. (U. S. Army Corps of Engineers, 1965)

Bureau of Reclamation Projects

About 17 miles of channel rectification through the Espanola Valley was completed a few years ago by the Bureau of Reclamation.

The initial stage of the San Juan-Chama Project designed to divert an annual average of 110,000 acre-feet of water from the San Juan River to the Rio Grande Basin is currently under construction. Public Law 87-483 authorized the Secretary of the Interior to construct, operate, and maintain the initial stage of the project. The principal purposes are (1) furnishing water supplies to approximately 39,300 acres of land in the Cerro, Taos, Llano, and Pojoaque tributary irrigation units in the Rio Grande Basin and approximately 81,600 acres of land in the existing Middle Rio Grande Conservancy District, (2) for municipal, domestic, and industrial uses, and (3) providing recreation and fish and wildlife benefits. The principal works of the project consist of three major elements: (a) diversion dams and conduits; (b) storage and regulation facilities at Heron Reservoir, and (c) structures for the water use facilities. The diversion conduits and the regulating reservoir are designed to permit ultimate diversion of an average of 235,000 acre-feet of water annually to the Rio Grande Basin. All imported water required to satisfy project uses either directly or by exchange will flow through Heron Reservoir and down the Rio Chama to the Rio Grande. This is the only existing project that will make additional water available in the Upper Rio Grande Basin and permit depletions in excess of those now existing.

Azotea tunnel, part of the diversion system, terminates at Willow Creek, several miles upstream from Heron Reservoir and has a capacity of 950 cubic feet per second. Heron Reservoir will have a capacity of 400,000 acre-feet and a surface area of 5,925 acres. An average of 8200 acre-feet of imported water is expected to be lost annually by evaporation at this reservoir.

The Llano unit extends along the east side of the Rio Grande from Velarde to the Santa Cruz River. A full water supply will be furnished for 2,280 acres of new lands and a supplemental supply for 2,333 acres. This unit will use 7,440 acre-feet of exchange water annually.

The Pojoaque unit would regulate streamflow of Nambe Creek to firm up the water supply for 2,768 acres of irrigated land along Pojoaque and Nambe Creeks. This unit will use 1,030 acre-feet of exchange water annually.

Rural Electrification

Rural electrification has a significant impact upon both rural farms and rural non-farm residents and their ability to utilize water and related resources more efficiently.

In 1966 about 8,500 consumers were being provided electric services in Rio Arriba County and used about 362 kilowatt hours each, which is about one-half the national average use per meter. Electrical service is being provided to customers throughout the area upon request and as the need arises.

photo

Channelization of Rio Grande south of Espanola. Bureau of Reclamation photo.

Photo
NM - P415-16

Contour chiseling and reseeding native grass pasture on Soil Association 2 on BLM land near Alcalde, New Mexico

To supply demands, the Jemez Mountains Electric Cooperative, Inc. has received approval for a substantial loan from the Rural Electrification Administration for construction of 11.5 miles of transmission lines and 319 miles of distribution lines to serve new customers; and for other improvements to the system.

Other Federal Lands

Bureau of Land Management (BLM)

Forty erosion control structures and stock tanks have been planned by the Bureau of Land Management for construction over a ten-year period, beginning about 1962. About one-half of these have been completed. Approximately 4,000 acres of pinyon-juniper in the Santa Cruz Drainage has been cleared and seeded to grass. Also several thousand acres of "big sagebrush" has been plowed and seeded in the Cebolla area. An active program of proper range management is being carried out on lands administered by BLM.

Bureau of Indian Affairs (BIA)

A program to construct debris basins and erosion control structures exists by which the Bureau of Indian Affairs provides funds up to $2,500 per Indian land allotment for construction funds to match the United States Department of Agriculture "ACP cost-share program". A program of clearing pinyon-juniper lands with seeding to grass is also being carried out on lands where this practice is applicable. To date about 5,000 acres have been cleared and seeded.

Photo
NM P415-9

Water catching device with storage tanks built on BIA property west of Espanola

State Developments for Recreation, Fish, and Wildlife

About 13,000 acres of elk and other game habitat adjacent to El Vado Lake are owned and managed by the State Department of Game and Fish. An elk herd has been planted in this area and about 2,000 acres have been cleared and seeded for forage. Another 4,200 acres for elk habitat near Chama just west of the Rio Chama was purchased by the Department in 1966. About 1,500 acres of this total is suitable for seeding which will improve the forage production substantially. The Department cooperates with other agencies and persons on preparing and utilizing small lakes of twenty acres or less for multi-purpose uses such as fishing, water for game, sediment retention, and for irrigation. Negotiations for easements are being made for permanent fishing rights in the area near Brazos and near Chama.

Projects of Conservancy, Irrigation, and Other Districts

El Vado Dam and Reservoir was completed in 1935 by the Middle Rio Grande Conservancy District. The reservoir is operated by the District to store and regulate water for irrigation within the framework of the Rio Grande Compact. When the reservoir is full, it has a surface area of about 3,500 acres and a capacity of 200,000 acre-feet. El Vado reservoir does not supply water for any lands in the sub-basin; however, the reservoir is extensively used for recreation, both fishing and boating.

The Santa Cruz Irrigation District, formed November 1925, completed the Santa Cruz Dam and Reservoir in February 1929. The reservoir was planned to have a capacity of about 6,700 acre-feet; however, the capacity as constructed was about 5,300 acre-feet. A sediment survey conducted in 1956 by the Soil Conservation Service showed the capacity reduced to 3,758 acre-feet.

About 4,300 acres of irrigated lands are served from the Santa Cruz Reservoir. The reservoir is filled to capacity almost every spring. In addition to water storage for irrigation, the reservoir provides fishing, boating, and other recreation facilities.

Soil and Water Conservation Districts are groups of landowners organized under State law to identify and combat problems involving soil and water. These districts using the programs of the Soil Conservation Service and Agricultural Stabilization Conservation Service are an effective force to fight water and soil waste.

Community Irrigation Ditch Systems are recognized political subdivisions of the State. All of the irrigation systems except the Santa Cruz Project and systems on Indian lands are operated by community irrigation ditch systems or "acequias".

There are nine "permanent type" diversion dams in the sub-basin, three of which were completed in 1965 and 1966. Control structures in the ditches are usually of wood, metal, or earthern plugs. Many turnouts consist of a simple breach in the ditch bank. Generally operation and maintenance of the ditch systems is carried out by the old "majordomo" method where most of the cleaning or repair work is done by members of the ditch system. In recent years some of the participants pay the acequia system a certain amount per day or hire someone to take their place. A general lack of maintenance is evident on most of the systems.

Public Assistance Programs

Public assistance programs exist to aid the disadvantaged in a number of areas, such as: financial assistance, technical skills, educational training, distribution of surplus foods or aid through the food stamp program, medical care, child welfare services, services for the blind, homes for the aged, and crippled children's programs.

Public welfare programs, which have grown steadily for a number of years, contribute much to the total economy of Rio Arriba County. In fiscal year 1945 about $300,000 was disbursed in public welfare, by fiscal year 1955, these disbursements reached more than $1,000,000, and by fiscal year 1966 total disbursements grew to $1,900,000 annually. Per capita payments

have grown from $12 in 1945 to $48 in 1955 and to $76 in fiscal year 1966.

Two Federal programs designed to combat "hard core" unemployment were the Area Redevelopment Act (ARA) and the Manpower Development and Training Act (MDTA). Both gave the New Mexico Employment Service the responsibility of identifying occupational training needs and the selection of trainees. The choice of training sites and the actual training are functions of the State Department of Education (New Mexico State Employment Service, 1965).

Proposed vocational program of the Northern New Mexico State School at El Rito, New Mexico, includes courses in the following areas: clerk-stenography, nurses' aide, farm machinery operator, cosmetology, business occupations, barbering, drafting, auto repairs, building trades, welding, home economics, and agriculture (New Mexico State Employment Service, 1965).

The Public Works and Economic Development Act of 1965 was enacted "to provide a means by which certain areas of the Nation suffering from substantial unemployment and underemployment can be helped to improve their physical and social structure and thereby stimulate economic growth". It is designed to provide new industry and permanent jobs in areas where they are most needed. Its main emphasis is on long-range economic development and programing for areas or communities that are burdened with persistent unemployment and low family incomes.

Soon after this act was passed, the "Four-Corners Area", including parts of the four states of Arizona, Colorado, New Mexico, and Utah, was established as an area eligible to receive assistance under Title V provisions of this act. The Four-Corners Area consists of 90 counties. Of

these, nine are in Arizona; forty are in Colorado; twenty-one are in New Mexico; and twenty are in Utah.

Also a number of counties or areas in New Mexico are considered to be "qualified areas under Title IV" of the Public Works and Economic Development Act (PL 89-136) administered by the U. S. Department of Commerce.

All of this sub-basin is within the Four-Corners Area and is therefore eligible to apply for assistance under either Title IV and/or Title V of the Act.

VIII

WATER AND RELATED LAND RESOURCE DEVELOPMENT POTENTIAL

This chapter describes some of the potential water and land resources available in the study area. Some ideas expressed here are not presently economically feasible or socially desirable. However as future social and economic changes occur these possibilities may become reality.

Land Availability for Potential Development

There are approximately 200,000 acres in small and scattered tracts that have suitable soils and topography for irrigation. These lands include fine-textured soils derived from shales, loamy soils from pumice, loamy alluvial soils, and loamy to fine-texutred soils on mesa tops. These lands have slopes less than 5 percent, deep to moderately deep soils that are relatively stable and usually clear of surface stones and gravel. (See Map - Land with Soils-Topography Suitable for Irrigation, Appendix I).

Land areas for industrial or recreational sites are practically unlimited. These sites could be located away from flood hazard and other factors that might restrain development.

Impoundments

The U. S. Bureau of Reclamation has made investigations of three potential reservoir sites in their studies of the San Juan-Chama Project. Two are to be used for irrigation and recreation and the

third site for irrigation regulation only (Table 19).

Reconnaissance investigations were made of six other potential reservoir sites during this study. Five could be used for recreation only and one could be used for irrigation water regulation. From surface examination it appears that they are suitable for dam and reservoir projects to regulate stream flows to help meet some needs for water, but each would require further study including water supply, water rights, site geology, and operating conditions that might be imposed by the Rio Grande Compact.

Waters of the Rio Grande Basin are fully appropriated and the effects of any new development on streamflow would have to be offset by a transfer of water rights or with imported water.

The El Rito, the Upper Vallecitos, the Rio del Oso, and the Abiquiu sites are on National Forest lands and access is available over unimproved dirt roads. The Nambe Falls reservoir site is on the Nambe Indian Reservation. Land acquisition for easements or rights-of-way are not considered to be a problem on the other three sites which are located on private property.

Groundwater Developments

There is adequate groundwater for stock and domestic use in the Santa Fe Group and valley alluvium along major drainages. This groundwater could be developed from relatively shallow (less than 500 foot depth) wells. Wells, in the above materials, could be developed for limited (less than 500 gpm) industrial or other uses. Any groundwater

Table 19, Location and capacity of potential reservoir sites examined, Chama-Otowi Sub-Basin, New Mexico, 1966

Location	Capacity (acre feet) Irrigation	Recreation
About 6 miles north of El Rito on El Rito Creek 1/	13,500	1,900
About 2 miles south of Village of Vallecitos on Rio Vallecitos 2/	1,600	4,700
Above Nambe Falls on the Nambe River 3/	1,500	0
About 5 miles east of Tierra Amarilla on Tierra Amarilla Creek	up to 10,000	0
About 6 miles northwest of Chama on Rio Chamita	0	76,000
About 5 miles south of Abiquiu on Abiquiu Creek	0	240
Near the abandoned town of San Lorenzo on the Rio del Oso	0	151
About 10 miles northwest of Canon Plaza on the Rio Vallecitos	0	10,300
About 4 miles downstream from Truchas on the Rio de Truchas	0	1,000

1/ Reconnaissance Report on El Rito Project, New Mexico, August 1964, Bureau of Reclamation.

2/ Reconnaissance Report on Rio Ojo Caliente Basin, New Mexico, August 1964, Bureau of Reclamation.

3/ San Juan-Chama Project, Colorado-New Mexico, November 1955, Bureau of Reclamation.

withdrawal from valley alluvium and the Santa Fe Group would affect flows in the Rio Chama and Rio Grande; therefore, the interest of downstream water users must be considered. Groundwater potential in the remaining part of the sub-basin is low. Some areas have adequate groundwater for stock and domestic use, but there are large areas which have little or no groundwater potential. (See Groundwater Map, Appendix I).

Channel Improvements and Levees

There are two areas where flooding of river bottomlands can be alleviated by levees and channel improvement. One area is along the Rio Grande from Velarde to south of Espanola, and the other is along the Rio Chama about one mile south of Chama. In the Espanola Valley the Rio Grande Floodway Plan is to construct new levees and rebuild existing levees in the Rio Grande and do channel stabilization and rectification. This is a joint plan developed by the U. S. Army Corps of Engineers and the U. S. Bureau of Reclamation.

A two-mile section of channel along the Rio Chama immediately below the bridge on Highway 84 at Chama could be improved by levees and channel realignment. This work would protect commercial property and hay and pasture lands from flooding when snow melts each spring.

Along the south side of the Rio Chama above Espanola, channel improvements and channel construction for side arroyos to the river could be carried out without any major construction problems but would require a continuing maintenance program. Land acquisition or rights-of-way for the channel across developed land would probably

be a major problem. Construction of these channels would reduce damage from floodwater to residential, commercial, and agricultural property.

Drainage

The high water table problem under about 13,000 acres of irrigated land can be effectively solved. Part of this problem can be solved by efficient delivery and application of irrigation water to croplands. A system of sub-surface drains can be effective in lowering the water table to a plant-tolerant level. It is possible that in several areas, along the Rio Grande and lower reaches of the Rio Chama, that a drainage pumping plant would have to be used because of inadequate or nonexistent outlet points. Pumping for irrigation from shallow wells would also be effective in most areas.

In part the problem in the Lyden and Velarde area can be solved by reestablishing the drainage systems installed during the 1930's.

Irrigation Systems

The inefficient irrigation systems can be improved to a more effective system of diverting and delivering water to the users by reorganization, consolidation, and construction of permanent-type control structures.

In the Northern Rio Grande Resource Conservation and Development area, plans and designs are being made for several diversion dams and reorganized irrigation systems.

The U. S. Bureau of Reclamation has completed reconnaissance reports of potential irrigation development and improvement for the Ensenada, Barranca, El Rito, and Rio Ojo Caliente projects. These proposed measures include irrigation storage, diversion dams, and reorganization and rehabilitation of irrigation.

Much of the potential development will not require more water than is presently being used for irrigation.

Recreational Developments

This sub-basin has great potential for meeting the projected demand for recreational developments required by our rapidly expanding population. An appraisal of potentials for outdoor recreational development in Rio Arriba County, New Mexico completed in April 1967 provides guidelines as to the kinds and the comparative ratings of recreation development judged to be most feasible. (Table 35). The greatest potential exists for recreation activities suitable for forested and mountainous areas. Provisions of the Rio Grande Compact and availability of water place limitations on development of water-based recreation. However, Heron Reservoir is envisioned for a major recreation development with basic facilities to include improvement of access roads, provisions of circulatory roads and parking areas, public boat-launching ramps, water and sanitary facilities, picnic and campgrounds, and administrative facilities. Additional accessory facilities such as a marina with restaurant and multiple guest units may be developed by the agency designated to administer the recreation centers, or by private concessionaires. Patronage of the area may also demonstrate the need for a lodge (U. S. Bureau of Reclamation, 1964).

The new Heron reservoir should contribute some 22,300 fishing days annually and Rio Chama fishing resources should be about doubled to 30,000 man-days. Willow Creek will provide a new 1,000 man-days fishing resources (Morris, 1965). Heron reservoir is expected to support 400 hunter-days annually with many water fowl available (Morris, 1965).

Recreational development appears to offer a great potential for generating added income and employment. Lakes on the Jicarilla Indian Reservation and on U. S. Forest Service lands provide fishing and boating enjoyment. Impoundment sites identified would add substantially in meeting future needs.

One specific development potential being regenerated is that of another recreational area along the Denver and Rio Grande Western Railroad from Alamosa to Pagosa Springs, Colorado through Chama, New Mexico. All kinds of recreation could be developed for year-round uses. A ski-motel-lodge complex could be developed to offer both indoor and outdoor recreation. This would contribute to a more feasible operation than if oriented toward a single-season activity.

There are a number of areas where recreational facilities could be developed. U. S. Forest Service plans additional recreation facilities. Obtaining adequate financing and a sufficient volume of recreation users to make the enterprise feasible would be two major problems to overcome in establishing privately-owned recreation facilities or services. Approximately 120 miles of potential new trails for hikers and nature lovers are found along the boundaries. About 85 miles of the proposed Continental Divide Trail lies along the western side

Skiing could be developed in Cumbres Pass near Chama, New Mexico

and about 60 miles of the proposed Trail's "East Leg" lies along the east boundary of the sub-basin (Bureau of Outdoor Recreation, 1966, pages 68-69).

Fish and Wildlife Developments

Greatly increased potential for fishing and water fowl habitat will develop from the San Juan-Chama transmountain diversion. Heron Reservoir will allow maximum compatable use for both fishing and water-based recreation (Bureau of Reclamation, 1964).

This is an outstanding area in the State for big-game development. The State Department of Game and Fish has long-range plans to establish elk herds throughout the Upper Rio Grande Basin from Albuquerque north to the Colorado-New Mexico State line. As funds become available to the Department, newly acquired areas for elk habitat will be cleared and reseeded to provide winter forage. Adequate winter forage located near herd range areas is the major problem to be overcome. Sufficient summer forage is usually found in high mountain areas.

Some of the most desirable bear and deer hunting in New Mexico is found within the sub-basin and will satisfy most of these hunting needs in the next 10 to 15 years.

Water Quality Control

Adequate sites and borrow material are available for building floodwater retarding structures, debris basins, channel barriers, grade stabilization and other structures which would reduce sediments reaching damage areas. Reduction of sediment in the Rio Chama and Rio Grande would improve the water quality of these rivers.

Photo
NM P303-5

Fresh reseeding job

photo
NM P303-1

Results of reseeding

Table 20, Potential impacts (physical and monetary) due to vegetative land treatment

Land Treatment	Unit	Potential Land Treatment Area	FS	BLM	BIA	Private	State	Water Yield Ac. Ft. Per Yr.	Water Benefits ($'s)	Sediment Reduction Ac.Ft./Yr	Sediment Reduction Benefits ($'s)	Forage Increase Tons/Yr.	Meat Production Benefit ($'s)	Average Annual Cost ($'s)	Average Annual Benefits ($'s)
Abandoned Cropland Management	Acres	1,000	70	-	60	870	-	-	-	0.3	400	300	3,000	750	3,400
Grasslands:															
Range deferred grazing	Acres	433,000	165,000	69,000	56,000	126,000	17,000	-	-	138	157,000	32,500	293,000	216,000	450,000
Range proper use	Acres	867,000	329,000	139,000	113,000	251,000	35,000	-	-	138	157,000	16,300	147,000	-	304,000
Range erosion control	Acres	53,000	8,000	11,000	9,000	23,000	2,000	-	-	17	18,000	14,000	124,000	52,000	142,000
High Mountain Snow Fence	Miles	700	294	-	-	406	-	5,600	123,000	-	-	-	-	140,000	123,000
Woodlands:															
Pinon-juniper, eradicate	Acres	66,000	45,000	5,000	4,000	9,000	3,000	-	-	20	23,000	7,000	63,000	65,000	86,000
Pinon-juniper, thin	Acres	402,000	165,000	88,000	32,000	96,000	21,000	-	-	64	73,000	27,000	243,000	280,000	316,000
Brushland:															
Sagebrush	Acres	166,000	42,000	23,000	29,000	60,000	12,000	-	-	55	62,000	42,000	378,000	242,000	440,000
Chapparral	Acres	93,000	25,000	4,000	14,000	50,000	-	19,300	425,000	30	34,000	23,000	207,000	99,000	666,000
Commercial Timber Management:															
Aspen	Acres	42,000	30,000	-	-	12,000	-	7,000	154,000	-	-	5,000	45,000	60,000	199,000
Spruce Fir	Acres	269,000	177,000	-	-	92,000	-	45,000	990,000	-	-	34,000	306,000	500,000	1,296,000
Ponderosa Pine	Acres	606,000	404,000	3,000	61,000	134,000	4,000	25,000	550,000	-	-	76,000	684,000	900,000	1,234,000
Phreatophyte Control	Acres	10,000	1,000	-	3,000	6,000	-	24,000	528,000	-	-	10,000	90,000	20,000	618,000
TOTAL IMPACTS								125,900	2,770,000	262.3	524,400	287,100	2,583,000	2,574,750	5,877,400

Land Treatment and Adjustments

Vegetation manipulation and land treatment practices can be used to produce more forage and timber, to increase water yields and to reduce erosion and sediment accumulations (see Table 20).

Land treatment considered to be essential for achieving maximum improvement in the resources are:

1. Reseeding abandoned cropland.
2. Improved grassland management.
3. Clearing or thinning pinyon-juniper woodlands.
4. Irrigation water management.
5. Erosion control.

About 1,000 acres of abandoned cropland producing about 15 percent of its potential could be reseeded with adapted species of grass, legumes, and browse. Small gullies should be treated with erosion control measures at the time of reseeding.

About 876,000 acres of rangeland needs reseeding of poorer sites, relocation of some service roads, and strategic location of erosion control measures, and continued range proper use including deferred grazing. Most ranges are in an improving stage; however, the average forage plant composition is rated only fair. Some erosion is occuring on most ranges.

About 30 percent of the sub-basin (732,600 acres) is covered with pinyon-juniper woodlands. These areas have limited resource values. They do, however, have a marked influence on the site on which they grow.

Being evergreens, the trees continue their photosynthetic processes yearlong with cooresponding consumptive use of soil moisture. The

Photo
NM P261-5

Pinyon-juniper eradication

Pinyon-juniper could be cleared from the areas of deep soils on slopes less than 10 percent (58,000 acres) and the disturbed areas should be reseeded to grass. For the areas of shallow soils and on slopes greater than 10 percent (402,000 acres), pinyon and juniper stands could be selectively thinned, in connection with a program of intensive erosion control, reseeding to grass and a program of good range management.

Irrigation water management can be improved through reorganized and lined conveyance systems, land leveling, and improved irrigation practices. It is possible to increase the irrigation efficiency from less than 40 percent to 65 percent or more. By installing these practices and increasing irrigation efficiency less fertility will be leached from the soil, crop yields will improve, need for subdrainage will

be reduced, and it is possible that a smaller diversion requirement will result with more water being passed unrestricted downstream.

Erosion control is needed on more than one-half the study area. Management and revegetation are the key practices. Other methods are gully plugs, rock and brush dams, debris basins, diversions to reduce concentration of runoff waters, net wire barriers, vertical slat snow fences on areas of sandy soil, and road and trail relocation and management. About 64,000 acres need intensive treatment which will require a combination of several of these practices.

Additional land management measures that would contribute to improvement in the natural resources are:

1. Snow fence erection.
2. Intensified commercial timber management.
3. Brush clearing and reseeding.
4. Phreatophyte control.

Snow fences and planting trees and brush in rows to help accumulate snow in depth could be carried out on about one-third of the 53,800 acres of high mountain meadows and alpine slopes. The deeper drifts will retard evaporation and the treated area will yield more water for downstream use.

Soil moisture and spring runoff amounts can be increased by designed harvest cutting and other timber stand improvement in commercial timber areas according to investigations by the U. S. Forest Service. Experimental block cutting of pine trees resulted in increased snow accumulations on the "clear cut" areas which yielded about 40 percent

more water than in the uncut areas. Strip cutting experiments have indicated that strips running perpendicular to streams form snow banks the full length of the strip. Because of this practice spring runoff is increased. Timber thinning permits more snow to reach the ground and improves the quality of the remaining stand. Of the 450,000 acres of commercial timber, 75,000 acres might be clear cut on a sustained yield harvest cycle.

About 40,000 acres of mountain chaparral can be treated on mountain meadows, old burns or slide areas, and along streams. This brush could be cleared on moderate slopes and thinned on steep slopes, then seeded to grass or browse. Storm runoff is slowed, soils are stabilized, and wildlife and domestic grazing potential is improved.

Sagebrush occupies about 177,400 acres of deep or moderately deep fine-textured soils on slopes less than 20 percent. Clearing and reseeding on 65,000 acres could be coupled with an intensive program of erosion control to provide more forage and improve water yields.

As of 1966 the area of riverbottom vegetation (phreatophytes) increased to 12,200 acres. These areas of "bosque" have aesthetic values as well as values for wildlife habitat. A program to control phreatophytes should keep in mind the need for landscape beauty and for escape cover and food for wildlife, thus small areas of "bosque" should be retained; likewise, vegetation adjacent to the stream channels should not be disturbed because of its value for channel stabilization. These areas could not be irrigated unless water rights are made available. The difference in water use between grass and deep-rooted phreatophytes should give a minimum savings of two-acre feet of water per acre per

year, or about 24,000 acre-feet of water annually.

Rural Electrification

An estimated 15,000 customers must receive service from electric cooperatives by 1975. Needed expansion may be financed by accumulated capital or by loans. This sub-basin has little potential for producing the needed electricity in the near future, thus electric consumption must be supplied from outside sources. The Plains Electric Generation and Transmission Company plant at Algodones, New Mexico, has a capacity listed at 50 megawatts. They have purchased rights to an additional 30 megawatts. Negotiations for another 50 megawatts, expected to be completed soon, will assure adequate power for the near future. Potential hydro-electric power sites are available on Rio Chama and Rio Brazos.

Unemployment and Welfare

Reduction in unemployment could be achieved by increasing harvesting and processing timber products. Recreational developments, intensified agricultural land use and changes to high-value specialty crops, increases in marketing and processing, and more industry could contribute substantially to reduction of unemployment and to increased incomes in the area.

Significant reductions in numbers of welfare recipients are possible in the next 10 to 15 years.

IX

OPPORTUNITIES FOR DEVELOPMENT AND IMPACT OF USDA PROGRAMS

Development

Potential PL 566 and Other Watershed Programs

The Watershed Protection and Flood Prevention Act, Public Law 566, as amended, provides for projects which may include watershed protection, flood prevention, agricultural water management, municipal and industrial water supply, recreation development, fish and wildlife, pollution abatement, and salinity control. The Federal government pays all costs allocated to flood control and cost-shares up to 50 percent of construction cost for agricultural water management, recreation, and fish and wildlife developments.

Field investigations indicate that three watersheds in the Chama-Otowi sub-basin have potential for development by 1980 under the authority of PL 566 as amended.

Espanola-Rio Chama Watershed: Includes 147,380 acres of which 22 percent is privately owned, 1 percent is State owned, 70 percent is Federal land, and 7 percent is Indian land.

The watershed investigation report proposes 14 floodwater retarding structures, 2 multiple purpose structures for flood prevention and recreation, and 21,120 feet of outlet channels and appurtenant structures. Estimated total cost of the structural program is $2,617,800. Public and private benefits accruing to the structural program are about $180,000 annually. The estimated annual cost is $89,000.

The investigation indicates that the total average annual damage amounts to $191,000. Damage reduction benefits of $153,000 annually would result from installation of structural measures. These benefits would accrue to about 450 farm units covering over 2,000 acres. Redevelopment and secondary benefits would amount to $27,000 annually.

An application for assistance under PL 566 has been submitted and approved. Local sponsoring organizations have indicated their willingness and financial ability to carry out the project. Investigations indicate a potential for development under the authority of PL 566 as amended.

Prior to including the two proposed multiple purpose structures in the plan, detailed analyses of the following will be required:

1. Design and cost estimates of structures.
2. Extent, cost, and manner of acquiring water and water rights for the project.
3. Probable operating conditions that may be imposed by the Rio Grande Compact Commission and other operating procedures required to safeguard existing water rights.
4. Cost allocation and the ratio of benefits to costs.

Sebastian Martin-Black Mesa Watershed: Includes 103,040 acres of which about 63 percent is Federal land, 26 percent is private and State land, and 11 percent is Indian land.

The watershed has been authorized for planning and a tentative work plan has been prepared.

The plan proposes 13 floodwater retarding structures, 8,650 feet of

diversions, and 2,610 feet of outlet channels and appurtenant structures. Total estimated cost of structural measures is $2,453,724, of which $2,425,900 is Federal cost and $27,824 is local sponsors' cost. The estimated average annual cost of installing structural measures is $86,400. Estimated average annual benefits from these measures is $162,000. Cost of land treatment measures on private land is $516,851, Federal land administered by the Bureau of Land Management $138,107, and National Forest land $43,975.

Present damages in the watershed are $174,000 annually. After the project is installed, these damages will be reduced to $35,000, an 80 percent reduction. The average annual benefit of $139,000 will benefit about 312 landowners. Other benefits will amount to $23,000 yearly.

Pojoaque Watershed: Includes about 153,555 acres of which 42 percent is Indian land, 38 percent National Forest, 14 percent private, 5 percent Federal land administered by Bureau of Land Management, and 1 percent State land.

The watershed investigation report determined that 5 floodwater retarding structures would be economically feasible. Total estimated costs for these structures is $1,714,540. Estimated annual equivalent cost plus operation and maintenance is $58,700. Estimated average annual benefits of these measures is $87,300. Some additional structural measures might be installed by USDA or other Federal agencies under other programs.

Installation of project measures will benefit about 150 farm units covering more than 2,600 acres. Direct damage reduction benefits will be $71,000 annually. Other benefits accruing to the general public will result from reduced risk due to flooding, better scheduling of farm and other activities, and uninterrupted travel.

Public Law 46 and Related Authorities

Public Law 46 is the authority that created the Soil Conservation Service. Present SCS programs under which land treatment might be accomplished are: (1) assistance to soil and water conservation districts, (2) Great Plains program (applicable to Santa Fe County), and (3) technical responsibility for the Agricultural Conservation Program of the Agricultural Stabilization and Conservation Service.

The land treatment suggestions described in this section are eligible for Agricultural Conservation Program cost-sharing where the treatment cost is borne by the farmer and rancher and the Federal government, and in special circumstances the State. Cost-share payments vary according to type of practice and the ability of farmer or rancher to pay his share.

Soil Conservation Service technicians assist cooperating farmers and ranchers in soil and water conservation districts by helping them work out complete conservation plans for their farm or ranch units.

Two project areas and various land treatment measures which may be accomplished by 1980 are as follows:

Intensive Land Treatment Project Area: This area is located in the southern part of the sub-basin and the City of Espanola is its center. The area is in the New Mexico Plateaus and Mesas Land Resource Area (See Major Land Resource Area Map, Appendix I).

While much of the land treatment in the project area would be accomplished by agency programs on Federal land, about one-half of the work would fall to private landowners and leasees of State land. All of the practices for private lands can be accomplished by presently available USDA programs. The practices proposed for the early action program would cost an estimated $3,075,000. The estimated average annual cost including operation and maintenance is $484,312, and estimated average annual benefits are $1,021,781. Table 21 shows practices, amounts, and costs and benefits. Definitions of land treatment practices are located in Appendix I.

Photo

Sediment source area in Soil Association 1, northwest of Espanola on Lovato Grant

Table 21, Land treatment and impacts by 1980 in intensive land treatment project area

Practice	Unit	Possible 15 year accomplishments (a) FS	(b) BLM	(c) BIA	(d) State	(e) Private	Total	% of needs	Annual cost 0/	Quantitative effects through 1980: Water Yield Increase ac.ft.	Water Yield Annual 1/ benefit	*Sed. reduction Red. ac./ft.	*Sed. reduction Annual 2/ Benefit	Net forage increase as beef Tons of forage	Net forage increase as beef 100# beef	Net forage increase as beef Annual 4/ benefit	Total annual benefit (dollars)
									$'s				$'s			$'s	$'s
Pinyon-juniper eradication	acres	10,860	5,184	370	272	246	16,932	68.5	27,731	-	-	5	5,645	1,778	582	14,550	20,195
Brush control	acres	6,561	6,420	1,920	0	4,374	19,275	72.2	29,938	489	10,758	6	6,774	4,816	1,577	39,490	57,022
Riparian vegetation control	acres	0	0	509	0	643	1,152	19.8	3,330	2,880	63,360	-	-	1,153	337	9,446	72,806
Deferred grazing	acres	7,742	65,352	61,937	9,564	85,618	230,213	98.7	230,213	-	-	74	83,546	11,510	3,770	94,382	177,928
Range proper use	acres	15,484	127,973	115,677	18,672	175,792	453,598	99.5	-	-	-	73	82,417	5,669	1,857	46,486	128,903
Range erosion control	acres	649	6,558	5,134	863	2,090	15,294	32.9	29,699	-	-	5	5,645	3,822	1,251	31,340	36,985
Sediment & erosion structures	no.	214	66	31	8	77	396	35.7	42,144	-	-	216	243,864	-	-	-	243,864
Gully plugs	no.	710	761	355	101	608	2,535	20.0	18,305	-	-	24	27,096	-	-	-	27,096
Fencing 5/	miles	176	216	115	30	150	687	57.9	22,345	-	-	-	-	-	687	17,175	17,175
Ripping 5/	acres	0	11,110	4,478	1,259	0	16,847	56.0	24,544 2/	-	-	5	5,645	421	138	3,452	9,097
Wells 5/	no.	0	46	34	0	35	115	60.5	27,683	-	-	-	-	-	3,870	96,750	96,750
Stock ponds 5/	no.	23	127	145	13	102	410	67.4	28,380	-	-	-	-	-	4,484	112,100	112,100
Total average annual									484,312	3,369	74,118	408	460,632	29,168	18,553	465,171	999,921

0/ Amortized at 5% interest for various years by individual practices.
1/ Value of water estimated at $22.00/acre foot.
2/ Cost includes two ripping treatments in 15-year period, first at $7.50/acre, second at $3.75/acre.
3/ Value of sediment held on land estimated at 70¢/cu.yd. or $1,129.00/acre foot.
4/ Value of beef estimated to average $25/cst next 15-year period.
5/ Practices are complimentary to deferred grazing, range proper use, and reseeding practices.
(a) FS-USDA - National Forests and Grasslands, administered by Forest Service.
(b) BLM-USDI - Public Domain Lands, administered by Bureau of Land Management
(c) BIA-USDI - Indian Lands, administered as trust lands by Bureau of Indian Affairs.
(d) State - Land owned by State of New Mexico - under long-term lease to farmers and ranchers.
(e) Private - Patented land under private ownership.

* Sediment

Total annual cost: $ 484,312
Total annual benefits : 999,921

Table 22, Average annual monetary expression of vegetative land treatment accomplishments, 1968-1980 and 1980-2020

Land treatment	Unit	Total potential	USDA PROGRAMS				OTHER AGENCY PROGRAMS				USDA AND OTHER AGENCY PROGRAMS POTENTIAL FROM 1980-2020				Total benefits
			Early action program accomplishments (acres)	Average annual $ benefits			Early action program accomplishments (acres)	Average annual $ benefits			Remaining acres	Average annual $ benefits			
				Water	Sediment	Meat production		Water	Sediment	Meat production		Water	Sediment	Meat production	(dollars)
Abandoned cropland management															
Gully control and reseed to grass	acres	1,000	200	-	100	500	-	-	-	-	800	-	300	2,500	3,400
Grassland management															
Range deferred grazing	acres	433,000	308,000	-	111,000	208,000	125,000	-	46,000	85,000	0	-	-	-	450,000
Range proper use	acres	867,000	615,000	-	111,000	104,000	252,000	-	46,000	43,000	0	-	-	-	304,000
Range erosion control, gully control, reseed, road maintenance	acres	53,000	10,300	-	3,700	24,000	11,000	-	3,700	26,000	31,700	-	10,600	74,000	142,000
High mountain snow fence	miles	700	90	16,000	-	-	-	-	-	-	610	107,000	-	-	123,000
Woodlands (pinyon-juniper)															
Eradicate, reseed, gully control	acres	66,000	36,000	-	14,000	34,000	6,000	-	3,000	6,000	16,000	-	6,000	23,000	86,000
Thin, reseed, gully control	acres	402,000	-	-	-	-	-	-	-	-	402,000	-	73,000	243,000	316,000
Brushland control															
Sagebrush - clear, reseed, gully control	acres	166,000	12,000	-	13,000	85,000	9,000	-	7,000	43,000	44,000	-	42,000	250,000	440,000
Chaparral - clear or thin, reseed, gully control	acres	93,000	10,000	106,000	7,000	51,000	3,900	43,000	5,000	21,000	26,100	276,000	22,000	135,000	666,000
Commercial timber stand improvement															
Aspen - manage for regrowth	acres	42,000	4,600	30,000	-	9,000	-	-	-	-	19,400	124,000	-	36,000	199,000
Spruce-Fir - thin, block and strip harvest	acres	269,000	18,300	67,000	-	21,000	-	-	-	-	250,700	923,000	-	285,000	1,296,000
Ponderosa pine - thin, prune, block and strip harvest	acres	606,000	78,200	73,000	-	50,000	10,300	8,000	-	7,000	517,500	469,000	-	627,000	1,234,000
Streambottom vegetation control															
Phreatophyte control - clear and reseed	acres	10,000	1,000	52,800	-	9,000	500	26,400	-	5,000	8,500	448,800	-	76,000	618,000
Subtotal				344,800	259,800	595,500		77,400	110,700	236,000		2,347,800	153,900	1,751,500	
Total $ benefits						1,200,100				424,100				4,253,200	5,877,400

Dryland Terracing Project Area: About one-half of the dry cropland is located on clayey soils in Soil Association No. 4 in the vicinity of Nutrias, Tierra Amarilla, and Cebolla. A terracing project is feasible on more than 4,000 dryland acres during the early action program period. This would reduce the erosion and sediment yield from the area and allow for better use of the precipitation. Provisions for this type of project are made through the technical services of the Soil Conservation Service and cost-share arrangements of the Agricultural Conservation Program.

Public Law 87-703 - Resource Conservation and Development Program: The sub-basin is included in a Resource Conservation and Development Project. One of the basic objectives of the RC&D program is the orderly development, improvement, conservation and utilization of natural resources of the project area, thereby providing employment and other economic opportunities to the people of the area. The RC&D program is applicable where the acceleration of current conservation activities plus the use of other authorities will provide additional opportunities to local people. There are about 200 irrigation systems in the sub-basin needing improvements that can best be met by project type action. It is estimated that by 1980 approximately 75 percent of these needs may be met through project-type programs. Information on these systems is included in Table 23, Appendix II. The total costs for project-type programs are estimated at $2,695,740 of which 75 percent, $2,021,800, would be expended by 1980.

Nineteen communities need project action relative to water distribution and/or sewer systems. Project-type programs are now being considered

Photo ORC-39-6

Pita Salazar holds basket of Casados Products for sale on local markets.

by several of these communities. See Table 25, Appendix II, for names and other data. An estimated 80 percent (15) of these communities may follow through with project action by 1980.

There are 10 areas involving 13,000 acres needing project action relative to land drainage. The total cost of project measures is estimated at $260,000 of which $105,000 may be spend by 1980 for draining 5,200 acres. Location and cost data are shown in Table 24, Appendix II.

The City of Espanola has plans to improve its water-distribution system and enlarge the sewage-disposal system. Nine RC&D project measures (PM-8, 58, 79, 116, 120, 130, 141, 160, 168) are in the planning stage relative to Espanola.

The Medanales Watershed project is being planned for installation with RC&D funds. At present 9,600 feet of diversion channel with appurtenant structures are planned. Estimated construction cost is $43,000.

Approximately 600 sediment control structures with a capacity of about 20 acre feet each may be installed by 1980.

Six potential reservoir sites have been located and are considered as possible RC&D project measures which may be completed during the early action program period using funds other than USDA. Water for these project measures would need to be obtained from imported water or by the purchase and retirement of existing water rights. Five of these reservoirs could be used for recreation water storage and the other for storage of irrigation water. The sites are located on Tierra Amarilla Creek, Rio Chamita, Abiquiu Creek, Rio del Oso, Rio Vallecitos, and Rio de Truchas. The construction cost for these six reservoirs is estimated at $3,365,700.

Additional RC&D project measures recommended for inclusion in the early action program may include:

1. Marketing co-op in the Espanola area. This could increase monetary returns and decrease cost of inputs.
2. Landing strip near Herron Dam would increase employment during construction and improve access and increase income from recreation.
3. Denver and Rio Grande Western Railroad passenger operation in the Chama area would increase recreation and thereby increase employment and income.

4. Skiing facilities in Cumbres Pass area would increase income and employment from recreation development.
5. Improved crop production both quantity, quality, and types of crops to be grown (high return crops).
6. Technical training school expansion in Espanola and El Rito featuring skills needed in the area and in adjacent areas.
7. Develop and publicize recreational uses in the Espanola and Chama areas.
8. Encourage industrial development of low-water consuming industries, such as (1) pressed board or pressed wood plant which would utilize sawmill wood now burned as scrap, (2) firewood marketing, using scrap wood from sawmill operations, (3) possible apple storage facilities to accumulate apples during peak harvest for marketing after peak harvesting periods, (4) growing, managing, and harvesting of Christmas trees, (5) possible garment manufacturing, or electronic assembly plants.
9. Locate additional water impoundments sites for recreational use, public and private.
10. Locate additional campsites in selected areas, public and private.
11. Develop 300 miles of nature trails along the Continental Divide and selected areas.
12. Develop game production and processing facilities in the Chama and Espanola areas.
13. Develop vacation farms and ranches on private lands.

14. Las Tablas magnetite taconite mining development.

15. La Madera-Petaca-Hopewell lake mining area redevelopment.

16. Access roads to mining area.

17. Canning and/or food processing plant in the Espanola area.

18. All-weather roads along school bus routes (example, road to Coyote for children of school age living in Canones).

Photo
NM P326-16

Hybrid sweet corn having from 2 to 3 ears per stalk sold as a cash crop. Farmer Lester Whitney.

Table 23, Proposed structural measures for flood prevention, agricultural water management and recreation to be accomplished by 1980

Item	Unit	Quantity	Construction cost (dollars)	Program
Floodwater retarding structures	No.	32	4,413,000	PL 566
Multiple purpose structures	No.	2	172,000	PL 566
Outlet channels	Ft.	23,730	30,000	PL 566
Diversion channels	Ft.	8,650	59,000	PL 566
Diversion channels	Ft.	9,600	43,000	RC&D
Drainage systems	Acres	5,200	105,000	RC&D-ACP
Irrigation system improvement	Acres	35,000	1,915,000	RC&D-ACP
Recreation structures	No.	5	2,641,800	RC&D-ACP
Irrigation water storage	No.	1	723,900	RC&D-ACP
Total cost			10,102,700	

Cooperative State-Federal Forestry Programs

The State-Federal cooperative forestry programs provide for fire protection and control of all State and private lands. The National Forests are protected by the Forest Service. The Bureau of Land Management is responsible for fire protection on the public domain and the Bureau of Indian Affairs assumes the responsibility for the Indian lands.

In the special case where State and private lands are within the boundaries of National Forests, the Forest Service provides fire protection on a fee basis. Also, if agreeable with the National Forest concerned, private lands immediately adjacent to its boundaries may be protected. The State Forestry Department signs an agreement with private owners and, in turn, contracts with the National Forests to provide the service.

The cooperative program provides assistance to private timberland owners, loggers, and other primary processors of forest products to place timberland under good forestry practices, eliminate waste, and improve the quality of wood products.

The cooperative tree planting program is designed to supply private landowners with suitable stock and seed for establishment of windbreaks and shelter belts and for forest plantings.

These programs are financed jointly by Federal, State, county, and, in some instances, private funds. The State Forester administers these programs and periodically submits claims for reimbursement based on mutually agreed upon financial plan.

Photo NM P533-111

Typical water impoundment on private forest land

The National Forest Recreational Survey

The National Forest recreational survey and the Division of Wildlife Management have designated twenty-seven sites in the sub-basin on the Carson National Forest as appearing to have water impoundment potential. Surface areas total approximately 600 acres, ranging from two to sixty acres in size. Only cursory examination of these sites was made, and further investigation will be necessary to determine feasibility.

The New Mexico Department of Game and Fish assisted the Forest Service, Division of Wildlife Management with the selection of ten of the above sites.

A listing of the sites, locations, and size, surface acres is tabulated in Table 27, Appendix II.

National Forest Development and Multiple-Use Programs

The National Forest development programs include water, timber, range, recreation, and wildlife habitat all designed with multiple-use concepts in mind. The Carson and Santa Fe National Forests have development programs within the Chama-Otowi Sub-Basin for all the resources.

Land treatment measures to be installed on the Carson and Santa Fe National Forests will enhance watershed values by retarding erosion and stabilizing the soil and, as a direct result, improve water quality. It is estimated that in excess of 100,000 acres would benefit from installation of land treatment practices.

Vegetative manipulation to increase water yield is a development program on both the Carson and Santa Fe National Forests. Studies have revealed that water yield can be increased by vegetation manipulation, i.e., strip and block cutting, clear cutting, and thinning of commercial stands, elimination of pinyon, juniper, and chaparral.

The following depicts the vegetative manipulation possibilities on the National Forests. Part of this will be implemented by 1980 depending upon the availability of funds.

Type	Area (acres)	Increase in water yield (area inches)	Total yield (acre-feet)
Mixed conifer	195,400	2.0	32,567
Ponderosa pine	443,900	0.5	18,496
Aspen	30,300	2.0	5,050
Total	669,600		56,113

If the small area of chaparral (10,000 acres) is converted to grass, an additional increase of water yield of 2,083 acre feet might be expected.

An important forest resource is timber of which there are about 454,815 acres in the Chama-Otowi Sub-Basin classes as commercial. In keeping with the development program for the National Forests as outlined in 1966, it may be exptected that the timber harvest in the Carson and Santa Fe Forests will be accelerated to attain the allowable annual cut of 42,400,000 board feet, an increase of 80 percent over the present harvest of 23,660,000 board feet. This increased harvest will come about by 1980 if the demand for wood products so dictates. The increase in employment will be proportional. The following is a summary of the timber operation in the sub-basin by jurisdiction:

Jurisdiction	*Avg. cut	Allowable cut	**Employees
Forest Service	23.6	42.4	252
BIA	1.3	1.8	14
State & private	8.5	2.0	92
Total	33.4	46.2	358

*Million (MM) board feet
**Year around. No figures on seasonal.

The long-range objectives for the development and management of the National Forest rangelands are (1) to intensify management to preserve the existing satisfactory conditions, and (2) improvement measures application to areas having unsatisfactory conditions.

Range improvement measures expected to be applied by 1980 include fences, stock-water developments, sagebrush, and pinyon-juniper eradication with conversion to grass.

It is not anticipated that these improvements will allow for any significant increases in the number of livestock but that the improved range would make for improved watershed conditions and increased pounds of beef.

The National Forest Project Work Inventory is a list of the non-recurrent work which should be initiated to meet public needs.

The basis for determination of project needs are: approved management and development plans, and the knowledge, vision, and judgment of Forest Service personnel in subject areas looking into the future to provide the best possible data based on foreseeable needs.

The project work pertaining to water and related land resources, inventoried by the Carson and Santa Fe National Forests and falling within the boundaries of the Chama-Otowi Sub-Basin is listed in Table 2, Appendix II.

The development programs include accelerated recreation site developments to meet projected demands. The National Forest Recreation Survey expects the use to almost triple by the year 1976. To keep pace with the projected demand it will be necessary to develop recreational sites and erect facilities at an accelerated rate.

The use, to a reasonable degree of accuracy, is based on facilities. On this basis, the visitor-days use by 1976 may be expected to reach 1,230,000 and to require 1,070 acres of additional land for development of facilities.

The development program for wildlife habitat intends to provide openings and trailways in dense stands, develop food patches in sparse areas and leave cover strips and patches in woodland areas scheduled for clearing. Fish

habitat will be enhanced by stabilizing banks, planting streamside cover, and constructing channel improvements.

There are at present within the sub-basin on National Forest lands, 390 miles of fishing streams and 40 acres of fishing lakes. The long-range wildlife program is pointed toward improvement of the present fishing waters to the extent possible. Creation of new fishing waters is limited to lakes and reservoirs. New construction during the early action program period could provide approximately 600 acres additional of water surface for fishing and other forms of water sports.

Rural Electrification

The Rural Electrification Administration makes loans to rural electric cooperatives for reloan to members. These loans enable members to purchase and install wiring, electrical, and plumbing equipment.

The 1980 power requirement is expected to more than double the 1965 rqquirements. The present number of meters is estimated to double in the next 15 years. Recent loan approval for construction of 12 miles of transmission line and about 300 miles of distribution line was obtained to meet the elctrical power needs of current and new consumers. Negotiations have been completed for 30 more megawatts and are expected to be completed for an additional 50 megawatts of power.

The electric cooperatives appear to have the financial capabilities necessary to meet power development needs during the next 10 to 15 years either from loans or from capital accumulations. Local interest appears favorable toward meeting future requirements of electrical power.

Impacts

Physical Effects

The USDA land treatment program recommended for the early action program period on the proposed intensive land treatment project area will increase water yield by 20,500 acre-feet per year, reduce sediment reaching damage area by 220 acre-feet per year, and increase beef production by 1,040 tons per year. Debris basins, gully plugs, and floodwater retard structures will reduce sediment to damage area by another 245 acre feet per year. This reduction amounts to 465 acre feet per year or 48 percent reduction during the early action program period due to U. S. Department of Agriculture programs. Two proposed dams by other agencies will increase reduction to 50 percent. This reduction will enhance water quality from the Abiquiu Dam on the Rio Chama and the Embudo Station on the Rio Grande to the Otowi Station at the lower end of the sub-basin. Flood protection projects proposed in the three PL 566 watersheds and the Resource Conservation and Development Project at Medanales will reduce flood damage by 53 percent ($345,560). Table 24 shows percent flood damage reduction for PL 566 and RC&D watersheds.

The increased water yield, increased forage and reduced sediment yield to the damage area as a result of land treatment and structural measures will have a wide sphere of inter-related influences on the sub-basin (see Table 21). Figure 6 shows the net qualitative impact and relationship of proposed project measures on the economy of the area. Land treatment is considered the first increment and, when applied, in many cases will reduce the amount of structural measures and agricultural water management necessary.

Economic Effects

Improvements in efficiencies would have a tremendous effect upon the total economy. Efficiencies may take the form of greater production of livestock and crops with same quantity of imputs such as land, labor, and capital producing the same quantity of output with fewer imputs such as less labor, water, or fertilizer. These efficiencies are greatly dependent upon the management abilities and techniques utilized in the area. The economic impact of proposed measures is shown in Table 25.

Reorganization of irrigation systems, combining parallel systems, and lining ditches would tend to reduce diversion requirements by improving transportation efficiencies and would reduce the labor required to operate and maintain these systems. Production of agricultural crops on under-utilized lands would return an estimated net of $2 per acre. Shifting to higher value crops would greatly increase efficiency of use of water, labor, land, and capital utilized in production of agricultural crops.

Table 24, Watershed flood protection projects, area controlled and percent flood damage reduction

Watershed	Total area (acres)	Area controlled (acres)	% area controlled	% flood damage reduced	Status
Santa Cruz	117,184	11,712	10.0	45	Installed
Sebastian-Martin	109,312	22,400	20.5	80	Potential
Pojoaque Creek	153,555	48,384	31.5	32	Potential
Espanola-Rio Chama	147,379	27,392	18.6	80	Potential
Medanales	7,000	405	5.8	70	Potential
Total	2,445,421	*174,293	7.1	53	

*100 square miles non-contributing to streamflow

Figure 6, Impact and relationship of proposed measures on economy of Chama-Otowi Sub-Basin

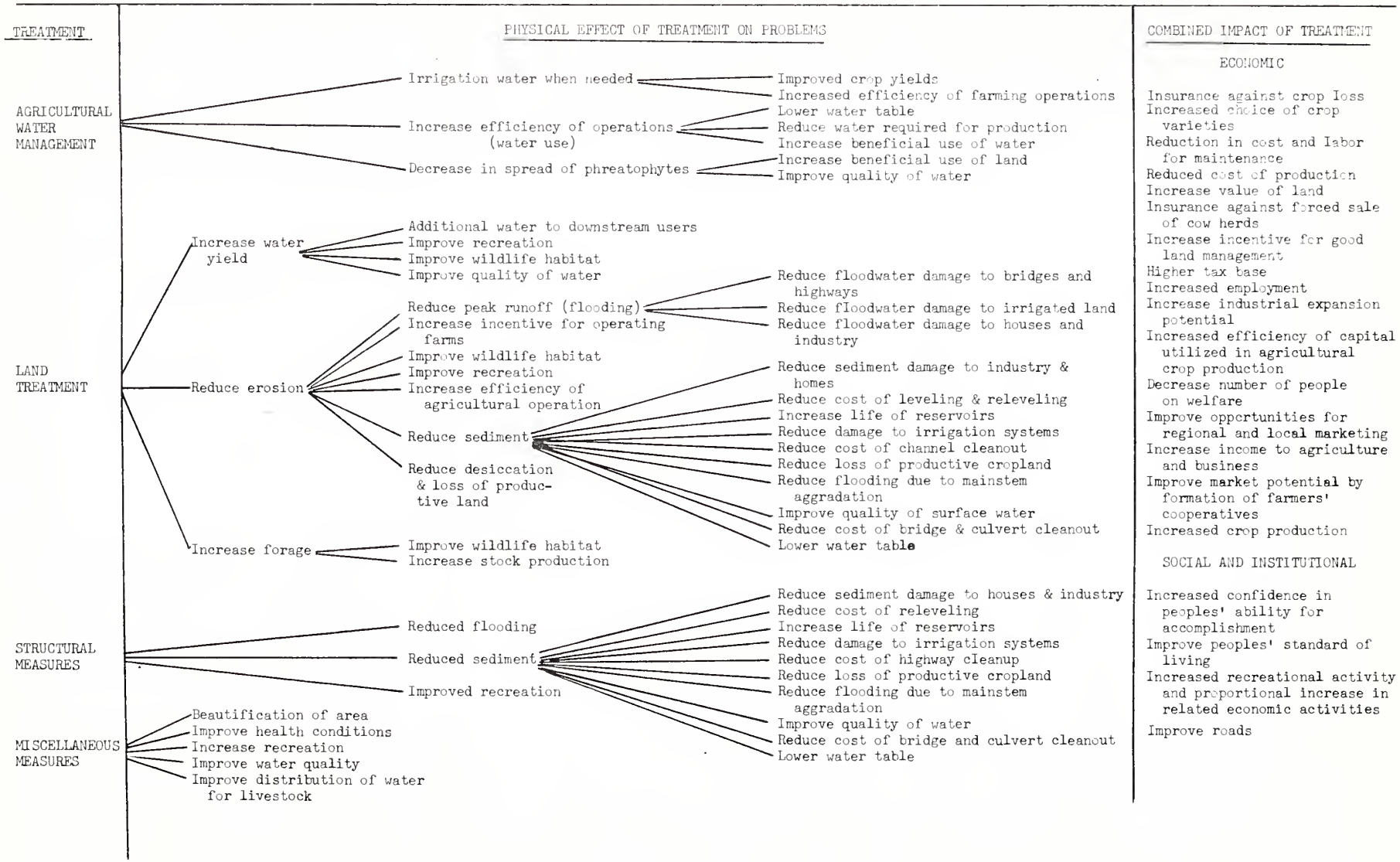


Table 25, Economic impact of USDA programs in Chama-Otowi Sub-Basin

Measures	Early Action Program Accomplishments: Costs & Benefits in Early Action Program Period: $ Cost (av. ann.)	$ Benefit (av. ann.)	Estimated Economic Benefit (after installation): Av. Ann. Man-Years Employment	Increase in Av. Ann. $ Income	Potential After Early Action Program Period: Cost & Benefit Potential After Early Action Program Period: $ Cost (av. ann.)	$ Benefit (av. ann.)	Estimated Economic Benefit (after inst.): Av. Ann. Man-Years Employment	Increase in Av. Ann. $ Income	USDA Program
Structural 1/	63,000	101,000	5	19,000	358,000	573,000	27	107,000	PL 566, RC&D, ACP
Land Treatment 2/	401,000	763,000	30	120,000	2,275,000	4,823,000	171	683,000	ACP, PL 566
Other Projects 3/			67	236,000			382	1,338,000	RC&D, ACP
Total	464,000	864,000	102	375,000	2,633,000	5,396,000	580	2,128,000	

1/ See Table 23

2/ See Table 22

3/ Additional RC&D Project Measures

Income and Employment

Income and employment impacts from USDA proposals will differ depending upon the proposals accepted as feasible. Income will be increased substantially by greater efficiency in use of irrigation water, and increased production from alternative crops such as reseeded pastures, vegetable crops like chili, sweet corn, tomatoes, and lettuce. Vegetable production would enhance economic returns to producers and would add seasonal employment opportunities for a limited number of local people.

Production and Stabilization

Marketing crops at suitable grades or quality is the only reason of the need for producing any agricultural crop. Opportunities for regional and local marketing appears to be limited by population, consumer preferences, costs of marketing in both local and distant markets. Apples are currently purchased locally for shipping to distant markets. Markets for vegetables grown in sufficient quantities and suitable qualities could be developed both within and outside the State.

Climatic conditions are unfavorable for developing a stable production of fruit crops. Freezes, hailstorms, and thunderstorms affect the stability of vegetable production but a potential for greater production of these crops exists in the area.

Producers could gain from the group effort of being able to purchase production supplies in large quantities and sell the products at a favorable price in large quantities.

Recreation Opportunities and Benefits

Opportunities exist for development of recreational facilities; however, there are limitations on waters for fishing ponds which must be taken into consideration. In some areas of the United States, hunting privileges returned an additional $1 to $5 per acre (Hamor, 1967). Most USDA proposals would be of such a nature that the recreational benefits would be supplementary to other benefits, thus serving as an enhancement to a total project.

Cleaning streams, forming pools, and providing feed or stocking streams would encourage additional use of some streams which are otherwise satisfactory habitat for fish and wildlife.

From limited information on recreational enterprises it appears that management is the major factor in any successful recreational operation.

Land Use and Availability

Changes in land use are evident in many areas, especially in urban communities. Mobile homes are set up as semi-permanent structures in Chama. Permanent homes are being built in the vicinity of Espanola and in rural areas along Highway 84 near Tierra Amarilla and Park View. About three-fourths of the total land area of 2,445,000 acres is owned by Federal or State governments and by Indians; therefore, only about one-fourth of the land area is available from private ownership for uses such as municipal, industrial, agricultural, or home sites.

About two-thirds of the total land area is Federal public lands available for public recreational use within the requirements necessary for proper use

and management. Most of the State land serves a recreational function for the public. Many of the private lands are available for public recreational uses such as hunting, fishing, hiking, and horseback riding on a fee basis.

Social and Institutional Impacts

Social and institutional changes will occur as projects are approved and implemented. Some attitudes may change from that of doubt to that of confidence in their ability to accomplish jointly what individuals cannot do alone. As incomes of some entrepreneurs increase, the level of living will normally increase which will encouragé others to improve their position. Visible evidence of success from improved management, increased forage production, increased returns from shifts to higher value crops should be incentive for accelerated implementation of feasible projects.

X

COORDINATION AND PROGRAMS FOR FURTHER DEVELOPMENT

This section deals with programs:

1. For which the U. S. Department of Agriculture has no authority, or
2. That need legislation to make them a reality, or
3. That are alternatives to programs already mentioned.

Some aspects of these programs can be coordinated and put into action by the Steering Committee of the Northern Rio Grande Resource Conservation and Development Project through their associated action groups.

Pinyon-Juniper Thinning (selective cutting)

This is not a widely accepted practice because of the hand labor required. Studies to determine effects on (1) water yield, (2) forage increases, and (3) sediment and erosion control could influence private land owners and Federal agencies to make this practice part of their conservation programs. It could also provide State and County Agricultural Stabilization and Conservation Service-Agricultural Conservation Program Committees and Great Plains Conservation Program Committees with information with which to develop cost share and administrative programs that would encourage and financially assist individual farmers and ranchers to undertake this practice.

Phreatophyte Control

Farmers are not usually interested in methods of phreatophyte control because they cannot determine personal financial benefits of the practice. A program designed to encourage and financially assist individual farmers

to selectively clear out portions of bottomland vegetation could be initiated by a cost-sharing or total cost program financed and administered by State and Federal agencies. Eradication of phreatophytes in many instances would reclaim land for the production of beneficial forage for livestock and would reduce non-beneficial consumption of water in an over-appropriated stream system. Such programs might be beneficial for an entire stream system, thereby calling for a unified effort of all people in the system to bring about and pay for the cost of feasible projects of this kind.

Snow Drift Control

The U. S. Forest Service has determined through experiments that strategically placed snow fences (vegetative or mechanical) on alpine meadows can control snow drift formation thereby altering snow melt runoff patterns. Snow is captures in drifts on the meadows and thus retards evaporation. The alpine meadows in the Rio Brazos headwaters area are privately owned. Federal and State agencies could enter into agreement with the private landowners for installation of snow fences at State and Federal cost.

If ten percent of the 24,000 acres of alpine meadows in this project area could be treated, water production for use at lower elevations could be increased 150-200 acre feet per year.

Photo

Photo

Snow drift control on high mountain grasslands by construction of vertical slat snow fence.

U. S. Forest Service photos

Water Importation for Development of Potential Irrigation

The 200,000 acres of additional land which can be irrigated in the sub-basin would require that 500,000 acre feet of water be obtained annually for irrigation.

Water Importation for Development of Potential Recreation

The seven potential recreation sites would require an initial 80,000 acre feet of water to fill and an additional 600 acre-feet per year to maintain the water level. The storage could be obtained from the water imported by the San Juan-Chama Project. If not, the water would have to come from other sources.

Pump Irrigation

On the irrigated bottomlands in the lower reaches of the sub-basin, a change for ditch-type irrigation practices to well pump irrigation practices could promote several economic and conservation benefits. Some of these benefits are:

1. A full season water supply would be available.
    a. Farmers could plan operations knowing they would not lose crops from lack of water.
    b. A wider variety of crops could be grown.
2. Sprinkler irrigation would be feasible. Some of the high water table areas have a coarse textured soil and sprinkler application is applicable.
3. Less water would be used.
    a. Over irrigation would be discouraged.
        (1) Minimize soil losses.

(2) Minimize leaching of nutrients from soil.

b. Many porous ditch facilities could be abandoned.

(1) Less system maintenance.

(2) Less damage from floodwater and sediment.

c. Make phreatophyte control easier.

4. Stream pollution by refuse and chemicals carried in tail water could be minimized.

This program is an alternate for part of the water management proposals in the previous section. A change such as this would require conformance with statutes governing the appropriation and use of public waters and compliance with the rules and regulations of the New Mexico State Engineer.

Refuse Disposal Control

Disposal facilities for refuse are too few and many times are inadequate,

Photo P351-9

Uncontrolled dumping of refuse

consequently gullies, roadsides, and rangelands are used for disposal areas. These practices create health hazards, adversely affect the water quality in streams, and become deterrents to recreation and other beneficial uses of the land.

The practical approach to this problem would be the enactment of strict State, county, and municipal laws forbidding dumping except in designated places. The laws should be supplemented by providing convenient and frequent dumping areas near population centers. Fence enclosures could be constructed. Trash would be picked up often enough to avoid being a nuisance and taken to a burning area or sanitary fill. Enclosures should be constructed near main highways and roads and be well marked so they are easy to find.

Zoning Laws

Zoning laws need to be developed to cope with future population and economic expansion in the area. Responsibility for this type project lies with county and municipal commissioners. It is desirable that zoning laws complement future plans of State and Federal agencies. Zoning boards should include county commissions and representatives for municipalities, the State, U. S. Forest Service, Bureau of Land Management, Bureau of Indian Affairs, and other organizations interested in total resource development of the sub-basin. Items that should be considered are: (1) locations for industrial growth, (2) areas for home sites, (3) restrictions on future use of bottomlands to limit loss of life and property from floods, (4) location of garbage and refuse disposal areas, (5) areas for agricultural expansion, (6) locations for future highways and other transportation facilities, (7) sources of water and sewage disposal

facilities for future domestic needs, (8) location of school sites and other municipal, county, and State management facilities, (9) regulation of roadside advertising, (10) preservation of good agricultural land for agricultural purposes, and (11) preservation of natural beauty spots and recreational sites, (12) game management areas.

Range Bank Project

An alternate approach to rangeland protection by good range management practices would be a program similar to the "soil bank" program of several years ago. A "range bank" approach would differ in that rangelands would be retired for a period of years until vegetation could be re-established and erosion and sediment control facilities installed and developed. This would be a temporary program, but could be extended indefinitely for rangelands on which it was determined that grazing was not in the best community interest.

Badlands Recreation

Thirty thousand acres of badlands (areas of geologic erosion with little or no plant cover) are present in this study area. Several large areas in the vicinity of Pojoaque and Santa Cruz could be planned for scenic recreation areas with overnight camping facilities. This might be added to the State park facilities or be developed by the county or a municipal park authority.

Land Treatment Benefits After 2020

About 33 percent of the potential annual benefits due to land treatment can be realized within the next fifteen-year period. The remaining 66 percent represents $4,253,200 a year in benefits that will not be available

to the sub-basin during the next 15 years if the present trends and program plans remain unchanged. See Table 22.

Other Agency Programs and Their Impacts

Other Federal and State agencies have programs to develop water and land resources to improve the economic well-being of the people. The benefits of some of these programs are already evident.

Planning and action programs to improve and extend works for irrigation and drainage of farm lands are being carried out by the U. S. Bureau of Reclamation (USBR) and the U. S. Bureau of Indian Affairs (BIA). Studies are being made by the USBR of the potentials for salvaging water through control of phreatophytic vegetation and elimination of open water surfaces and swampy areas. Range management programs involving controlled grazing, vegetation manipulation, and erosion control are being accomplished by the Bureau of Land Management and the Bureau of Indian Affairs on lands under their jurisdiction. Prevention of overbank flooding, regulation of floodwaters, improvement and rectification of stream channels are being studied by the Corps of Engineers. Some of these programs have been accomplished. Facilities for importing water are now being constructed by the Bureau of Reclamation. Part of this imported water will be available for use in the sub-basin. Other programs being carried out on a continuing basis are water measurement, collection of climatic information and agricultural experimental work to provide data and information that is required for adequate planning of resource developments and administration of available water supplies.

Some of the programs are designed to meet local and emergency situations only; and others deal with a minor part of the problems of the area. These shortcomings might be aided by better authorities, financing, and coordinated efforts between local interests and water resource development agencies.

Many Federal agency programs are useful in furthering the economic well-being of both rural and urban people needing assistance. Frequently it is difficult to determine what the nature and purpose of a program is, what the eligibility requirements are, where to apply, which agency administers the program and whom to contact for information. A new publication entitled, "Catalog of Federal Assistance Programs" dated June 1, 1967, appears to be a complete, accurate composite answering the above questions in detail. This catalog was produced by the Office of Economic Opportunity, Washington, D. C. 20506, and contains all domestic assistance programs of the Federal government.

U. S. Bureau of Reclamation (USBR)

The USBR has authorized participating units, the Llano and the Pojoaque, and several alternate units of the San Juan-Chama Project in the sub-basin. They are:

1. Llano Unit, an irrigation project along a narrow bench paralleling the Rio Grande from Velarde to the Santa Cruz River. The project would consist of necessary canals and structures to efficiently deliver water to project lands.
2. Pojoaque Unit, an irrigation project to rehabilitate the existing facilities along Nambe and Pojoaque Creek. The project would include Nambe Falls Reservoir.
3. The El Rito Project area is the irrigated land in the vicinity of El Rito and Las Placitas. The project would consist of a multiple purpose storage reservoir, irrigation canals, and structures to provide water to project lands.

4. Rio Ojo Caliente Project area is along the Rio Ojo Caliente from La Madera to about five miles above the confluence of the Rio Chama and Rio Ojo Caliente. The project would consist of a multiple purpose storage reservoir, irrigation canals and structures to control and deliver water to project lands.

5. Ensenada Project, an irrigation project located in the vicinity of Brazos and Tierra Amarilla would consist of canals and water control structures to deliver water to project lands. Incomplete studies were made in 1953 along with the San Juan-Chama Project.

6. Barranca Project lands for irrigation development lie along the Rio Chama between Abiquiu Dam and the confluence of the stream with the Rio Grande. Project measures would be canals and structures to consolidate the existing systems and provide efficient delivery of water to the irrigated areas.

ome of these projects could also be constructed under the RC&D Program or nder the PL 566 program.

ureau of Indian Affairs and Bureau of Land Management (BIA and BLM)

he BIA and BLM have long-range plans in their programs of erosion control, egetative manipulation, and proper range management and conservation.

Interagency Coordination

he USDA is interested in existing and potential agricultural and forest ands and is responsible for administration of the U. S. Forest Lands. Under uthority of PL 566, watershed protection, flood prevention, and land treatment rojects are being planned and constructed with cooperation of BIA and BLM. The orps of Engineers is charged with public civil works programs to plan, construct, nd operate flood control works. This is being carried out.

he USBR is authorized, at public request, to locate, construct, operate, and aintain works for development of water and reclamation of lands.

These projects are of greatest value when coordinated with other land and water development projects.

From an overall resource development standpoint, coordinated efforts on present and future problems is necessary. Future resource development projects should have interagency coordination to insure that all feasible features are included to make the most beneficial use of the resource being considered for development. This coordination may range from informal contacts between individuals to formal liaison between organizations and agencies. Considerable Federal, State, and local agency coordination has been accomplished and will be continued.

Exports - Alternative Approaches to Solving Economic Problems

Employment

Training programs will improve the job opportunities for local people both in and outside the area. When insufficient job opportunities are available to the young inexperienced job seeker, adequate or selective training offers a wider field of job opportunities. Most of the locally trained people would fill jobs in the sub-basin; however, some persons may choose to work outside the area and seek employment either permanently or temporarily elsewhere. Permanent workers would of necessity move from the area. Temporary workers could reside in the area most of the year, but could greatly improve income by working for short periods outside the sub-basin. As more people obtain full-time jobs locally, and as people move for fulltime employment outside the area, the general economic condition and level of living will improve.

Water

Improving the efficiency of water use by practices such as concrete ditch lining, selecting lower-water consuming crops, or accepting proven management techniques will improve economic well-being of the people. An economic alternative to using the water in New Mexico as it has been, or can be, used is to sell these water rights to another water user, industrial or agricultural. Any change in the place or purpose of the use of water would have to comply with the statutes governing the appropriation and use of public waters and in conformance with the rules and regulations of the State Engineer. Due to social or cultural pressures this alternative may not be acceptable; however, from an economic standpoint the approach is sound.

Livestock

Potential resource development includes improvement in rangeland and forage production which would probably be utilized as roughage for cattle and sheep. Increased forage production in the next 15 years estimated at 100,000 tons could produce an estimated 3,000,000 pounds of beef. Livestock, including beef cattle and sheep, are being shipped for sale from this area both in and out of State. Most of the increased production would be marketed outside the area to partially satisfy State and National needs.

Forest Products

Forest products are sold to satisfy both local and non-local needs. About 10 percent of the forest products harvested from the sub-basin are utilized in the area and about 90 percent of this local harvest is shipped outside the area. From estimates of national needs in the next 15 to 20 years, all forest products will be demanded at satisfactory prices.

Increased use of the forest products both locally and within the State could provide increased revenues to producers and savings to users within the State. Changes in long-standing specifications to allow greater utilization of our native forest products in State projects could greatly enhance economic returns to the forest industry.

Recreation

Activities such as hunting, fishing, swimming, boating, or water skiing are usually utilized and marketed at their source. Since the outdoor recreation product cannot be shipped out for use, people must come to the recreation site to use it. Outdoor recreation is growing at a phenomenal rate. By the year 2000 our national population is expected to nearly double and the resulting overall demand for outdoor recreation will triple (Texas A&M University, 1965). Northern New Mexico, especially this sub-basin, offers great potential for meeting and satisfying the growing demands for outdoor recreation. Growth in the outdoor recreation field will add impetus to any economic enhancement already underway.

APPENDIX I

APPENDIX I

Only that material which is considered necessary to a general understanding of the report is included in Appendix I. Technical data of interest to the technician desiring details relative to the report are included in Appendix II. A third appendix titled "USDA Water and Related Land Resource Projects and Measures Recommended for Early Action" has been prepared.

CONTENTS

EXPLANATION OF CHAMA-OTOWI SUB-BASIN MAPS

The maps presented in this report are designed to present a graphic story of the resources, problems, needs, and possible solutions identified during the course of study of the sub-basin. Eight of the maps can be considered as basic data. The remaining maps are either complementary to or have been developed as interpretations from these basic maps.

Basic Information Maps

Land Status shows geographical distribution of specific land tenure.

Geology is presented to show the basic geological features in the study area and their relationship to centers of population, stream systems, and transportation routes. It gives the reader an idea of the type of parent materials from which the soil of the area is derived.

Mean Annual Precipitation (climate) is presented to show both high and low precipitation areas. The map indicates those areas where attention should be focused for vegetative manipulation considerations which might increase water yield.

General Soils shows the general kinds of soil encountered. The map is supplemented with tables of (1) soil characteristics and related features, (2) interpretations, and (3) soil association descriptions. This map is not a substitute for a detailed soil survey but is helpful in making interpretations about water and land resources.

Vegetation shows the general kinds of vegetation and broad types of land use.

Major Land Resource Area indicates within the study area three general types of country which have similar conditions and on which similar project type of activities might occur.

1966 Transportation Routes shows both present and planned access routes.

Upper Rio Grande Basin is an orientation map for the reader relating the Chama-Otowi Sub-Basin to the Upper Rio Grande Basin. (map in front of report)

Interpretative Maps

Land Treatment is an interpretative map developed through study of the geology, mean annual precipitation, soils, land resource area, and vegetative maps. It is designed to present the reader with an idea of a broad framework of types of treatment needed and applicable to the study area.

Groundwater shows geographical distribution of available sub-surface water.

Lands with Soil-Topography Suitable for Irrigation is an interpretative map which presents the location of present irrigated lands, loamy textured soils which should be given first priority in the event additional water becomes available for irrigation development and clayey textured soils which should receive second consideration for irrigation development.

Present Erosion Status is an interpretative map developed from soils, precipitation, and vegetative maps which indicates the degree of severity of gross erosion on the land.

Erosion Hazard is an interpretative map developed to show what the gross erosion situation could eventually become should a land deterioration trend continue.

Areas of Potential Increased Water Yield Due to Land Treatment delineates land areas of potential increased water yield. The precipitation and land treatment maps were compared to make the interpretation map.

PL 566 Projects shows position and relationship of completed, planned, and potential project areas where the problems can be dealt with through the authorities of the Watershed Protection and Flood Prevention Act (PL 566).

Project Location shows development efforts now operating, being built, and proposed for action.

Recreation developed to show the location of existing and identified potential recreation developments.

SOILS OF THE PLATEAUS AND MESAS

(1) Shallow and moderately deep soils in terrace position: Series A-

Series B - rough broken land association.

This association occurs in the southern part of the sub-basin on severely dissected terraces of the Santa Fe geologic formation in the New Mexico Plateaus and Mesas Land Resource Area. Erosion has reduced most areas to a complex pattern of round-topped, steep-sided gravelly hills, and areas of steep barren badlands.

Series A comprises about 55 percent of the association. It is shallow to moderately deep and rapidly permeable. It is developing in gravelly alluvium on steep hillsides. A gravel pavement covers the brown to pale brown gravelly sandy loam surface layer. The surface layer is 10 to 16 inches thick. The subsoil is a pinkish gray gravelly loamy sand to about 18 inches. Substratum is stratified sand and gravel.

Series B comprises 15 percent of the association. It is a moderately deep, moderately permeable soil developing in sandy material from sandstones in the Santa Fe geologic formation. Series B has a brown sandy loam surface layer 18 inches thick over a pale brown strongly calcareous sandy loam subsoil to 30 inches. The substratum is white sand and loamy sand.

Rough broken land comprises approximately 15 percent of the association. Slopes are steep to very steep, generally more than 20 percent. Profiles usually gravelly or cobbly loamy sand but may vary from clay loam to gravel. Inclusions of badland in this unit are characterized by sheer

cliffs, sharp ridges, and V-shaped gullies. Badlands are ordinarily devoid of vegetation.

Small areas of Series N soils with moderately developed clay loam subsoils occur on mesa tops and make up 5 percent of the association. Narrow gravelly sandy alluvial bottomlands comprise about 10 percent of the association.

This association is used for grazing and wildlife. Vegetation consists of scattered juniper and pinyon trees, rabbit brush, cholla, blue grama, and sand dropseed.

Elevations range from 5500 to 8500 feet. Rainfall averages 10 inches and ranges from 8 to 14 inches. Moisture comes from torrential summer rainstorms that cause severe sheet and gully erosion. Mean annual air temperature is 51 degrees with a freeze-free period of 130-150 days.

(2) Deep soils on piedmont slopes: Series C-Series D association. This association occurs throughout the sub-basin, but mainly in the New Mexico Plateaus and Mesas Land Resource Area on foot slopes and alluvial fans in piedmont positions. It is subject to accumulation of soil materials from nearby steep geologic exposures and the erosive effects of runoff water from the same areas. Coarser textured sediments are deposited near the base of the geologic upland and the finer texutred materials are transported further down slope.

Series C comprises about 50 percent of the association. Soil is deep, rapidly permeable, and is developing on slopes of 1 to 10 percent. Average slope is 4 percent. A characteristic profile of Series C has

a pale brown calcareous, sandy loam surface layer to 16 inches over very pale brown strongly calcareous sandy loam subsoils to 48 inches.

Series D comprises 35 percent of the association. It is characterized by a moderately permeable brown or pale brown strongly calcareous loamy surface layer to 12 inches over a light brown strongly calcareous blocky silty clay loam subsoil to 24 inches. The underlying horizons may be loamy or sandy. Slopes range from 1 to 8 percent and average 3 percent.

Areas of deep fine textured soils make up 5 percent, and moderately deep and shallow sandy soils make up 10 percent of the association.

This association is used for grazing sheep and cattle and for irrigated cropland. Much of this land is suitable for irrigation farming if water were available. Chief hazard to cultivation is inundation by runoff water and burial by sand and silt from nearby slopes. Wind erosion is a problem when fields are not protected during the winter and spring.

Native vegetation consists of grass and desert shrubs with occasional pinyon or juniper trees.

Elevations range from 5,500 to 7,500 feet and average precipitation ranges from 8 to 12 inches. Moisture normally falls during summer months as torrential storms. Mean annual air temperature is 48-50 degrees, and the freeze-free period is 100-130 days.

(3) Deep bottomland soils: Series E-Series F-riverwash association. This association occurs throughout the sub-basin, but primarily in the southern part in the New Mexico Plateaus and Mesas Land Resource Area. The soils are alluvial and located on river bottoms and low terraces. Espanola is the center of the alluvial association and the valley is one-half mile to a mile wide.

Series E comprises 65 percent of the association. It is deep, moderately permeable, and moderately well-drained on level and nearly level slopes. It is characterized by brown loam surface layers to 18 inches over stratified pale brown sandy loam subsoils to 60 inches. The profiles are calcareous to the surface.

Series F makes up 25 percent of the association and is similar to Series C in association (2), but is located on river bottoms and alluvial fans near the river. Series F is moderately deep and permeability is moderately rapid. It is well-drained on level and nearly level slopes. Soil profiles characteristically have pale brown fine sandy loam surface layers to 20 inches over very pale brown sandy loam subsoil to 48 inches. Profile is strongly calcareous.

Riverwash comprises 5 percent of the association and occupies floodplains adjacent to river, "sand bars" within the river area, and dry stream beds. Loamy to gravelly soils are the predominant profile textures. Riverwash near the larger streams has water table within three feet of the surface. Vegetation usually consists of cottonwood, Russian olive trees, and willows. Very little herbaceous vegetation is found.

Small areas of deep fine textured soils comprise 5 percent of this association. Thirty percent of the association is affected by high water table and accompanying salinity.

Soils in this association are the important cropland areas in the sub-basin. Crops range from irrigated alfalfa and native grass pastures to intensively cultivated crops of chile, tomatoes, and other garden-type vegetables. Many orchards are grown on these soils.

Soils are subject to flood damage and sediment deposit. Phreatophytes invade idle fields. Water erosion is a problem on slopes over 2 percent and fields left unprotected over winter are subject to wind erosion.

Elevations range from 5,500 to 9,000 feet, but the larger part of the association is 5,600 feet. Precipitation ranges from 8 to 12 inches and averages 9.5 inches. Mean annual air temperature is 51 degrees and the freeze-free period is 146 days.

SOILS OF THE HIGH INTERMOUNTAIN VALLEYS

(4) Moderately deep and deep soils on shale. Series G-Series H association. Soils in this association are developing in soft, calcareous shales in the north and west part of the sub-basin. Parent materials for the soils are Cretaceous aged shales, and associated sandstones of the Mancos, Lewis, and the Mesa Verde geologic formations. Topography ranges from nearly level alluvial valleys to steeply sloping hills. Scattered rock outcrops and areas of shale badlands occur in this landscape.

Series G comprises about 45 percent of this association. Slopes range from 6 to 30 percent. Profile is moderately deep and slowly permeable.

It has a dark grayish brown silty clay loam surface layer to 10 inches over pale olive clay. Raw shale is usually encountered between 18 and 30 inches. Series G is used for range.

Series H comprises 40 percent of the association. It is developing on nearly level to sloping alluvial deposits. Profile is deep and slowly permeable with grayish brown silty clay loam surface layers to 10 inches over grayish brown, strong blocky silty clay subsoils to 28 inches. Substratum is stratified, light brownish gray silty clays or silty clay loams. Often the blocky subsoil is lacking. Much of series H is suitable for irrigation farming if water is available.

Shallow soils from sandstones and shale badlands make up 10 percent of this association. Small areas of Series N soils comprise 5 percent of this association and occur on flat ridgetops.

Most of the land in this association is used for grazing sheep and cattle. A few small irrigated fields are located near perennial streams and are producing alfalfa and small grain crops. Several dryland fields south of Tierra Amarilla are farmed to wheat.

These soils are slowly permeable and, when subjected to torrential summer storms, erode easily. Deep steep-sided gullies develop which are difficult to control.

Pinyon-juniper occupy the steeper slopes and sagebrush and blue grama grass cover the smoother valley areas.

This association is located between 7,000 and 9,000 feet elevation in the High Intermountain Valleys Land Resource Area. Average annual precipitation is 13 to 19 inches. Mean annual air temperature is 44 degrees with 90 to 120 freeze-free days.

SOILS OF THE MOUNTAINS

(5) Shallow soils on sandstone: Series I - rockland -sandstone association. Landscapes within this soil association are generally steep, broken, rocky areas associated with sandstones of Cretaceous age. The Dakota geologic formation is the main source of parent materials. This association is located in the central and northern part of the sub-basin in the Southern Rocky Mountain Land Resource Area.

Series I sandy loam comprises about 50 percent of the association. Profile is shallow and moderately permeable. Slopes range from 2 to 20 percent. Profile is characterized by grayish brown sandy loam surface layer to 6 inches over light brown sandy loam or light sandy clay loam subsoil to 15 inches over decomposing sandstone rock.

Rockland-sandstone occupies slopes of 20 to 100 percent and comprises 45 percent of the association. Slopes have 15 to 20 percent cover of sandstone rocks. Usually they are topped by a sandstone cap. North facing slopes have 80 percent vegetative crown cover and south facing slopes have 50 percent cover.

Narrow alluvial bottomland areas make up about 5 percent of the association.

This association is used for grazing and timber production. Most of the erosion occuring on soils in this association is geologic. Some

minor sheet and gully erosion occurs on deeper soils.

Ponderosa pine, oakbrush, big sage, pinyon, and juniper make up the predominant vegetation. Elevations range from 6800 to 9500 feet. Precipitation averages 17 inches. Mean annual air temperature is 43 degrees and the freeze-free period is 80 to 105 days.

(6) Shallow and moderately deep soils on mixed sandstones and shale: Series J-Series K association.

Landscapes within this association are characterized by steep stony slopes. Soils are developing in mixtures of geologic parent materials of late Tertiary and Cretaceous age. The soils may occur on steep stony colluvial slopes, or in areas of severely eroded sedimentary formations. This soil association is located generally in the western half of the sub-basin, in the Southern Rocky Mountain Land Resource Area. Parent materials are very mixed and are combinations of shales and sandstone.

Series J comprises about 55 percent of the association. It is developing on steep slopes in soft shale material. Series J is shallow and slowly permeable. The typical profile has a grayish brown sandy loam surface layer to 9 inches over a thin bleached pale brown fine sandy loam horizon. The subsoil is pale brown blocky silty clay over very pale brown silty clay substratum. Shale materials may be encountered below 15 inches.

Series K comprises 20 percent of the association. It also is developing on steep slopes but is associated with the sandstone member of the

geologic complex. Series K is moderately deep and moderately permeable. Profile typically has grayish-brown loam surface layer to 8 inches over brown weak blocky clay loam subsoil to 15 inches. The substratum is yellowish brown sandy loam that rests on decomposing sandstone rock. Rock may be encountered below 24 inches.

Inclusions in this association are very stony lands, 15 percent; alluvial bottomland 5 percent; and rock outcrops 5 percent.

This association is used primarily for pasture and range. Some timber production occurs at higher elevations. A moderate amount of erosion occurs on steep mountain slopes and a few gullies develop along foot slopes. Landscapes vary from nearly level grass parks to steeply sloping mountain slopes that are generally forested. The higher elevations have mixed conifer and lower elevations have pinyon-juniper cover. Elevations range from 6,500 to 9,000 feet. Precipitation averages 11 inches. Mean annual air temperature is 43 degrees, and annual freeze-free period is 80 to 120 days.

(7) Moderately deep and deep soils on conglomerate: Series L - Series M association.

Soils in this association are developing on steep forested slopes on gravel, sand, boulder conglomerate of granitic and quartz latitic debris and associated tuffs and lava flows. The Carson and El Rito geologic formations are represented. These soils are located in the eastern part of the sub-basin in the Southern Rocky Mountain Land Resource Area.

Series L comprises about 45 percent of the association. This soil is developing on slopes of 12 to 40 percent in mixed conifer forest. Elevations

range from 7,000 to 8,500 feet. Series L is moderately deep and permeability is moderately slow. A typical profile has a 30-40 percent stone and cobble cover of basalt, rhyolite, and quartzite. The surface layer is a dark grayish brown loam to 5 inches over a light brownish gray gravelly loam to 18 inches. The subsoil is a brown blocky clay loam over decomposing conglomerate rock at about three feet. The profile contains 10-50 percent fragments coarser than sand.

Series M comprises about 40 percent of the association. It is developing on 20-60 percent slopes under spruce-fir forests at 8,500 to 10,000 feet elevation. Stone and cobble cover of quartzite, basalt, rhyolite averages 60-70 percent. Series M is deep to moderately deep and moderately permeable. A 1-3 inch cover of duff lies over a 15-inch thick grayish brown stony sandy loam surface layer over light gray, brittle sandy loam horizon 8 inches thick. The subsoil is a light gray sandy loam over decomposing tuff at 30-40 inches. This association also includes loamy alluvial soils 5 percent; and rockland 10 percent.

Most of this association is used for production of forests for timber and for summer grazing. Small alluvial bottomland areas are often farmed to irrigated hay.

Vegetation consists of coniferous forest trees, aspen, chaparral, wild rose bushes, mountain mahogany, and many grass species. Elevations range from 7,000 to 10,000 feet and average annual precipitation is 18 inches but ranges from 15 to 35 inches. Mean annual air temperature is 40 degrees and the freeze-free period is 50 to 100 days.

(8) Moderately deep and deep soils from mixed Aeolian and alluvial materials:

Series N - Series O association.

Landscapes in this association are generally smooth nearly level to moderately sloping, uplands occuring in the central and southern parts of the sub-basin in the Southern Rocky Mountain and the High Intermountain Valleys Land Resource Areas. The soils are developing in mixed accumulations of fine-textured aeolian and alluvial materials of undetermined origin. Gravel is commonly found in the substratum.

A variety of geologic materials may occur below the soil profile. It is usually basalt rock, sandstone, or gravel layers, any of which serve as the nearly level base necessary for the development of the landscape.

Series N makes up about 60 percent of the association. It is moderately deep and slowly permeable. It has a brown to reddish brown loam surface layer 4 inches thick over brown blocky clay loam or light clay subsoil to 16 inches. Substratum is a strongly calcareous massive clay loam to 48 inches. Series N occurs on nearly level to gently sloping areas.

Series O comprises about 20 percent of the association. It is similar to Series N except it has a loam to clay loam subsoil. It occurs on gently to moderately sloping landscapes.

Included in this association are shallow soils on moderately steep slopes, 5 percent; sloping gravelly soils, 5 percent (this inclusion ordinarily occurs on the fringes of this association where the old terrace gravels are exposed); and a deep sandy loam soil in the vicinity south of Taos junction, 10 percent.

Most of this association is in native vegetation and is used for range and pasture. A few small areas of alfalfa and garden crops are irrigated.

Series N includes soils that are suitable for cultivation if irrigation water were available. Most soils are well-drained and permeability is moderate to slow. Erosion hazard is moderate when not protected by vegetation. Good crop yields are obtained when the soils are irrigated. Native vegetation is pinyon-juniper trees, a few ponderosa pine at higher elevations, big sagebrush, blue grama, galleta, and western wheat grass.

Elevations range from 6,000 to 9,500 feet. Average annual precipitation is 16 inches with a mean annual air temperature of 44 degrees and freeze-free period of 90 to 120 days.

(9) Moderately deep and deep soils on volcanic materials: Series P - Series Q - stony steep land association.

Soils within this association occupy steep mountain slopes to moderately sloping mountain mesas that are forested. The soils are developing in parent materials of volcanic origin. The mesa areas are underlain by Bandelier tuff deposits or sheets of basalt. The steep mountain slopes may be deep deposits of basalt rock or slopes covered with basalt stones and underlain by different geologic material. These landscapes occur throughout the sub-basin in the Southern Rocky Mountain Land Resource Area but are most frequently located in the southern part of the area on the north slopes of the Valle Grande.

Series P makes up about 40 percent of this association. It is moderately deep and slowly permeable. The soil is characterized by a dark grayish brown cobbly loam surface layer to 6 inches over a brown cobbly clay loam subsoil to 20 inches. The substrata is

pinkish gray lime cemented basalt gravel, cobble, and stone. About 30 to 60 percent of the solum is gravel and cobble. Slopes are generally 20 to 50 percent. Vegetation is pinyon-juniper woodlands and elevations range from 6,100 feet to 8,000 feet.

Series Q makes up about 25 percent of this association. This soil occurs in the spruce-mixed conifer zone at 8,000 to 10,500 feet elevation. Slopes range from 5 to 25 percent. The profile is characterized by a surface cover of gravel and stone and several inches of forest litter over a light gray or pink loam surface layer to 15 inches. The subsoil is pinkish gray or very pale brown blocky gravelly sandy clay loam or clay over weathering bedrock below 24 inches. The profile contains 15 to 30 percent gravel and cobble.

Stony steep land comprises about 20 percent of this association. It occupies slopes of 20 to 90 percent. Fifteen to 80 percent of the surface is covered with stone and gravel. The surface layer contains up to 80 percent gravel and cobbles.

Included in this association are shallow sandy loam soils on gentle slopes, 5 percent. These are developing from tuff bedrock at depths less than two feet. Also included are rock outcrops, 5 percent and loamy alluvial bottomlands, 5 percent.

This soil association is devoted to forest-timber production and to grazing. Erosion is moderate to severe on steep stony lands but is slight on other landscapes. Vegetation ranges from pinyon-juniper woodlands to spruce-fir forests. Elevations range from 6,000 to 11,000 feet. Precipitation averages 15 inches annually with a mean annual air temperature of 44 degrees and a freeze-free period of 70 to 110 days.

(10) Moderately deep and deep soils on granite: Series R - Series S association.

Soils in this association are developing in parent materials from igneous, Pre-Cambrian rocks such as granite gneiss and schist. Slopes range from 10 to 70 percent. Cobbles, gravel, and stone commonly make up 20 to 80 percent of the surface cover and profile composition.

Series R comprises 45 percent of the association. It occurs on steep foothills and mountain slopes in the pinyon-juniper zone at elevations of 7,000 to 9,000 feet. It is moderately deep to shallow and moderately permeable. The profile has a grayish brown stony loam surface layer to 6 inches and a light brownish gray very stony loam subsoil that rests on bedrock at about 20 inches.

Series S comprises 35 percent of the association. It occurs on steep and very steep mountain side slopes in the mixed conifer vegetation zone at elevations of 9,000 to 12,000 feet. Series S is moderately deep to deep and moderately permeable. This profile is similar to Series R, but is deeper and occurs at higher elevations. The dark grayish brown stony loam surface layer is 9 inches thick over brown stony loam that has 70 percent stones. Depth averages about 36 inches over rock.

Included in this association are stony lands, 5 percent; rock outcrops, 10 percent; loamy alluvial land, 5 percent.

This association is used for timber production and grazing. Much of the forest areas are grazed during the summer. In a few places alluvial bottomlands are irrigated for native hay. Vegetation ranges from pinyon-

juniper trees at lower elevations to spruce-fir forests and alpine grasslands at high elevations. Elevations range from 7,000 to 12,000 feet. Average annual precipitation is about 20 inches, but may range from 15 to 30 inches. Mean annual air temperature is 40 degrees and the freeze-free period is 50 to 100 days.

(11) Deep soils on glacial materials: Series T - Series U association. Soils in this association occur at high elevations throughout the subbasin. Major areas are northeast of Chama, northeast of Canjilon, and east of Pojoaque. They are located in the Southern Rocky Mountain Land Resource area. Geologic materials vary, but have a common factor of being mixed by glacial action. Slopes range from 10 to 50 percent. Cobble, gravel, and stone makeup 10 to 60 percent of the soil profile and surface stone cover may be as high as 50 percent.

Series T comprises 65 percent of this association. It occurs primiarily in the vicinity of Canjilon Lakes and is developing in mixed geologic materials that include Mancos shale, sandstone, and ancient terrace gravels. Elevation ranges from 8,000 to 10,000 feet. Series T is deep and slowly permeable. Characteristic profile has a dark grayish brown silty clay loam surface layer to 15 inches over a brown blocky sandy clay subsoil to 36 inches. Substratum is a brownish yellow stratified sandy clay to 60 inches with gravel and cobble content of 40 to 60 percent.

Series U makes up 20 percent of the association. It occurs on moderately steep to steep mountain slopes at 9,500 to 12,000 feet elevation. Series U

is deep and permeability is moderately rapid. Profile has pinkish gray loam surface layer to 8 inches over a reddish brown blocky stony sandy loam subsoil to 24 inches. Substratum is similar to subsoil, but is more gravelly. Bedrock may be encountered below three feet. Series U has many associated rock outcrops.

Included in the association are alluvial soils, 10 percent; and rock outcrops, 5 percent.

The soils of this association are used for summer grazing. Vegetation includes spruce-fir, aspen, oakbrush, grasses, and forbs. Elevations range from 8,000 to 12,000 feet. Average annual precipitation is 19 inches. Mean annual air temperature is 40 degrees, and the freeze-free period is 10 to 50 days.

Table A-1, Soil characteristics and related features, Chama-Ojo Caliente Sub-Basin, New Mexico

Map symbol	Soil name 1/	Position	Profile (dry)			Effective depth (inches)	Natural vegetation 2/	Elevation 100's ft.	Climatic zones 3/	Slope range	Average slope	Subsoil permeability	Runoff	Available water holding capacity (inches)	Present land use
			Surface layer 0-10"	Subsoil 10-40"	Substratum or parent material										
Series A, Series B, rough brokenland association															
	1 Series A	Steep upland	Pale brown gravelly sandy loam, granular, mildly alkaline slightly calcareous	Pinkish gray gravelly loamy sand massive, moderately alkaline strongly calcareous	Pinkish gray mixed sand & gravel moderately alkaline strongly calcareous	18	PJ-G	58-85	5-6	10-35	14	Rapid	Rapid	2	Range
	Series B	Steep upland	Brown sand loam massive, mildly alkaline, slightly calcareous	Pale brown sandy loam, moderately alkaline, strongly calcareous	White sand & loamy sand, mildly alkaline strongly calcareous	40	PJ-G	55-70	6	10-40	15	Moderate	Rapid	5	Range
	Rough brokenland	Very steep river breaks	A land type in gravelly terrace material from the Santa Fe geologic formation				PJ	57-70	6	20-60	25	--	very rapid	-	Range
Series C, Series D association															
	2 Series C	Gently sloping piedmont	Pale brown sandy loam moderately alkaline, slightly calcareous	Very pale brown sandy loam massive moderately alkaline, strongly calcareous	Pale brown sandy loam, massive, moderately alkaline, strongly calcareous	48	G	55-65	6	1-10	4	Moderately rapid	Slow	6	Range, orchards, farming
	Series D	Gently sloping piedmont	Pale brown loam granular moderately alkaline, strongly calcareous	Light brown silty clay loam blocky, moderately alkaline, strongly calcareous	Pink loam massive moderately alkaline, strongly calcareous	60	G	58-75	3-6	1-10	3	Moderate	Medium	10	Range, orchards, farming
Series E, Series F, riverwash association															
	3 Series E	Nearly level bottom land	Brown loam granular, moderately alkaline, slightly calcareous	Pale brown sandy loam massive mildly alkaline slightly calcareous	Light gray sandy loam, mildly alkaline, strongly calcareous	60	G	55-90	3-6	0-5	1	Moderate	Slow	10	Farming orchards pasture
	Series F	Nearly level bottom land	Pale brown fine sandy loam massive, moderately alkaline, strongly calcareous	Similar to surface layer	Similar to surface layer except sandy loam	48	G	55-85	3-6	0-5	1	Moderately rapid	Very slow	8	Farming orchards pasture
	Riverwash	Active floodplain	A land type in sandy alluvium			--	B-T	57-65	6	0-5	1	--	--	-	Wildlife

4 Series G, Series H association	Series G	Strongly sloping upland	Dark grayish brown silty clay loam granular, moderately alkaline, strongly calcareous	Pale olive clay massive, moderately alkaline strongly calcareous	Light olive brown soft shale	24	PJ-SB	70-90	2-3	0-30	15	Slow	Very rapid	4	Range
	Series H	Gently sloping upland	Grayish brown silty clay loam granular, moderately alkaline, slightly calcareous	Grayish brown silty clay blocky, moderately alkaline strongly calcareous	Brownish gray silty clay loam, massive, moderately alkaline strongly calcareous	60	SB-G	70-90	2-3	0-6	2	Slow	Rapid	10	Range farming
5 Series I, rockland, sandstone association	Series I	Sloping upland	Grayish brown sandy loam granular neutral	Light brown heavy sandy loam, massive neutral	Yellowish brown sandstone	15	MC	68-95	3-5	2-20	8	Moderate	Rapid	2	Range timber
	Rockland sandstone	Steep mountains	A land type in steep sandstone breaks			--	PJ-B	65-85	3-5	20-100	30	--	Very rapid	-	Range
6 Series J, Series K association	Series J	Strongly sloping mountains	Grayish brown sandy loam granular neutral	Pale brown silty clay blocky medium acid	Very pale brown silty clay, massive, strongly acid	15	PJ-MC	65-90	3-5	3-40	20	Slow	Rapid	2	Range timber
	Series K	Strongly sloping mountains	Grayish brown loam, granular neutral	Brown clay loam blocky neutral	Yellowish brown sandstone rock	24	PJ-MC	70-90	3-5	10-40	20	Moderate	Rapid	4	Range timber
7 Series L, Series M association	Series L	Strongly sloping mountains	Dark grayish brown loam granular slightly acid	Brown clay loam blocky medium acid	Pinkish gray decomposing conglomerate	36	MC	70-85	2	12-40	15	Moderately slow	Rapid	6	Timber range wildlife
	Series M	Steep mountains	Grayish brown stony sandy loam granular neutral	Light gray sandy loam, massive medium acid	Pale brown decomposing volcanic tuff	40	SF	85-100	2	20-60	40	Moderate	Rapid	5	Timber range wildlife
8 Series N Series O association	Series N	Nearly level upland	Brown loam granular neutral	Brown clay loam blocky, moderately alkaline	Light brown clay loam massive, moderately alkaline strongly calcareous	48	SB-PJ	60-85	3-6	0-5	2	Slow	Medium	8	Range
	Series O	Gently rolling upland	Brown loam granular, mildly alkaline	Pale brown loam blocky, moderately alkaline, slightly calcareous	Very pale brown sandy loam, massive, mod. alkaline st. calcareous	36	PJ-SB	65-95	3-6	5-15	8	Moderate	Medium	6	Range
9 Series P, Series Q Stony steepland association	Series P	Steep mountains	Dark grayish brown cobbly loam granular neutral	Brown cobbly clay blocky mildly alkaline	Pinkish gray lime cemented basalt gravels and cobbles	30	PJ	61-80	3-5	20-50	30	Slow	Rapid	5	Range
	Series Q	Moderately sloping mountain mesa	Pink loam, blocky, medium acid	Pinkish gray gravelly sandy clay loam blocky neutral	Pink weathering bedrock of volcanic tuff & pumice	24	MC	80-110	2	3-25	10	Moderate	Medium	4	Timber Range
	Stony steepland	Steep mountains	Land type in steep volcanic rubble			-	PJ-MC	57-100	2-6	20-100	30	--	Very rapid	-	Range wildlife
10 Series R, Series S association	Series R	Steep mountains	Grayish brown stony loam granular neutral	Light brownish gray very stony loam, massive neutral	Fractured granite, gneiss, & schist	20	MC	70-90	2	20-60	35	Moderate	Very rapid	3	Timber range
	Series S	Steep mountains	Dark grayish brown stony loam, granular slightly acid	Brown stony loam, massive slightly acid	Fractured granite, gneiss and schist	36	SF	90-120	2	30-70	40	Moderate	Very rapid	3	Timber range
11 Series T, Series U association	Series T	Strongly sloping mountains	Dark grayish brown silty clay loam, granular medium acid	Brown sandy clay blocky slightly acid	Brownish yellow mixed clay & stones	60	G-C	80-100	2	5-50	12	Slow	Medium	7	Range Wildlife
	Series U	Steep mountains	Pinkish gray loam granular very strongly acid	Reddish brown stony sandy loam blocky, strongly acid	Reddish brown stony gravelly sandy loam, massive, strongly acid	36	G-C	95-120	2	15-50	30	Moderately rapid	Medium	5	Range timber wildlife

1/ Series names are not correlated.

2/ PJ - Pinyon-Juniper G - Grass MC - Mixed Conifer
B - Brush SF - Spruce-Fir
T - Broadleaf Trees SB - Sagebrush C - Chaparral

3/ Maker and Dregne, 1952, Climatic Zones of New Mexico

Table A-2, Soil interpretive groupings, Chama-Otowi Sub-Basin, New Mexico

Map Symbol	Soil Name	% of Assoc.	Capability Unit Dryland	Capability Unit Irrigated	Range Site	Hydrologic Group	Unified Eng. Class 1/	Erosion Hazard
1. Series A, Series B, Rough broken Assoc.	Series A	55	VIIe	-	Hills	B	SM	Severe
	Series B	15	VIIe	-	Hills	A	SM	Very Severe
	Rough broken land	15	VIIIe	-	-	D	ML	Very Severe
	Other soils	15						
2. Series C, Series D Assoc.	Series C	50	VIe	-	Sandy	B	SM	Moderate
	Series D	35	VIe	IIe	Loamy	B	ML-CL	Moderate
	Other Soils	15						
3. Series E, Series F Assoc.	Series E	65	VIe	I	Bottom land	B	SM-SC	Slight
	Series F	25	VIIe	IIIs	Bottom land	B	SM	Slight
	Riverwash	5	VIII	-	-	A	GM	None
	Other Soils	5						
4. Series G, Series H Assoc.	Series G	45	VIe	-	Clayey	D	CL	Severe
	Series H	40	IVe	IVe	Clayey	D	CH	Moderate
	Other Soils	15						
5. Rockland, Series I, Sandstone Assoc.	Series I	50	VIIe	-	Shallow sandstone	B	SM-SC	Slight
	Rock land sandstone	30	VIIIe	-	Breaks	D	SM	Moderate
	Other Soils	20						
6. Series J, Series K Assoc.	Series J	55	VIIe	-	Mountain Shale	C	CL	Slight
	Series K	20	VIIe	-	Mountain Loam	B	SC	Slight
	Other Soils	25						
7. Series L, Series N Assoc.	Series L	45	VIIe	-	Forest	B	ML-CL	Slight
	Series M	40	VIIe	-	Forest	B	SM	Slight
	Other Soils	15						
8. Series N, Series O Assoc.	Series N	60	VIe	IIIe	Loamy	C	CL	Moderate
	Series O	20	VIe	-	Loamy	B	ML-CL	Slight
	Other Soils	20						
9. Series P, Series Q Assoc.	Series P	40	VIIe	-	Malpais	C	CL	Moderate
	Series Q	25	VIe	-	Mountain Loam	B	SC	Slight
	Stony Steep land	20	VIIIe	-	Breaks	D	ML-CL	Moderate
	Other Soils	15						
10. Series R, Series S Assoc.	Series R	45	VIIe	-	Forest	B	ML	Slight
	Series S	35	VIIe	-	Forest	B	ML	Slight
	Other Soils	20						
11. Series T, Series U Assoc.	Series T	65	VIIe	-	Subalpine Grassland	C	SC	Slight
	Series U	20	VIIe	-	Subalpine Grassland	B	SC	Slight
	Other Soils	15						

1/ Classification is for control section (10 - 40")

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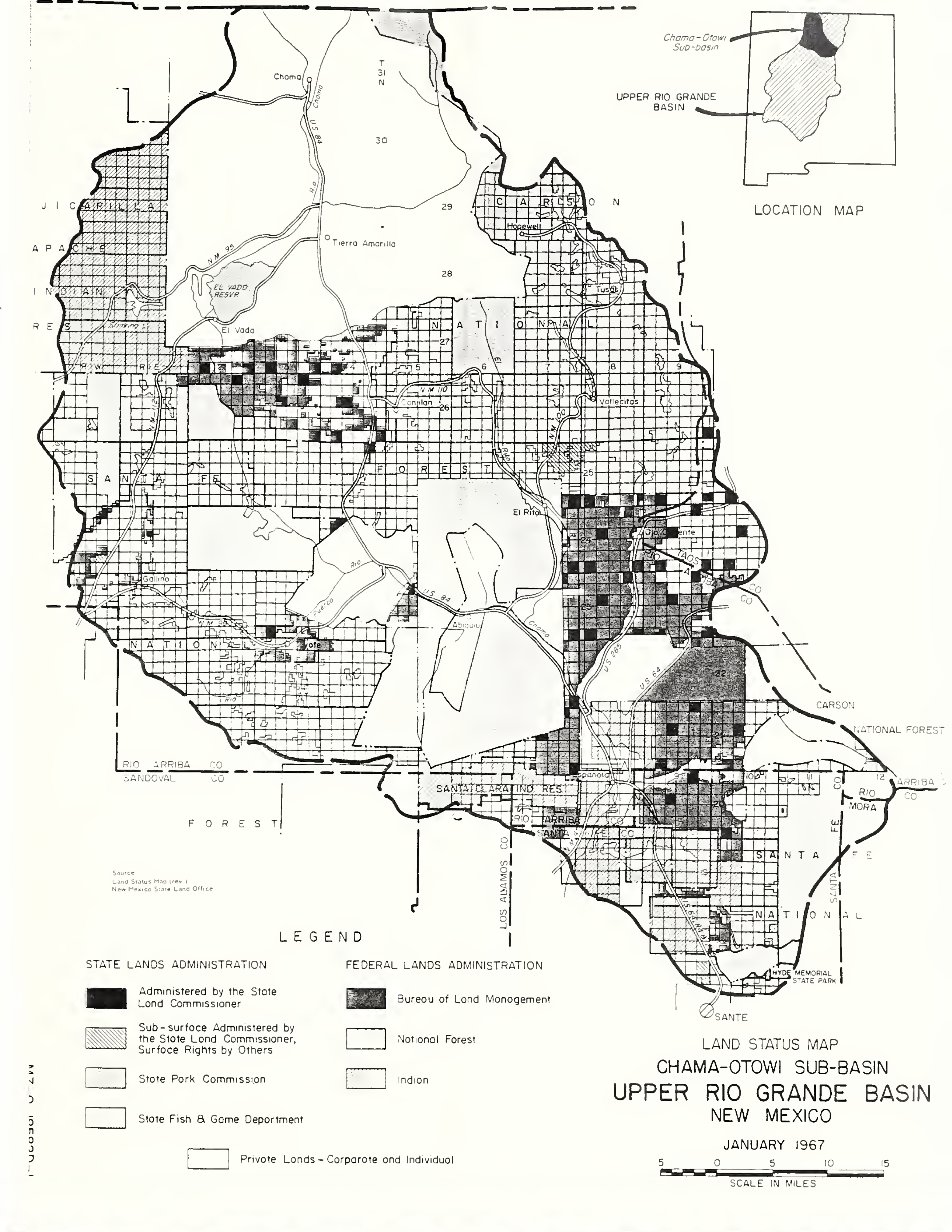
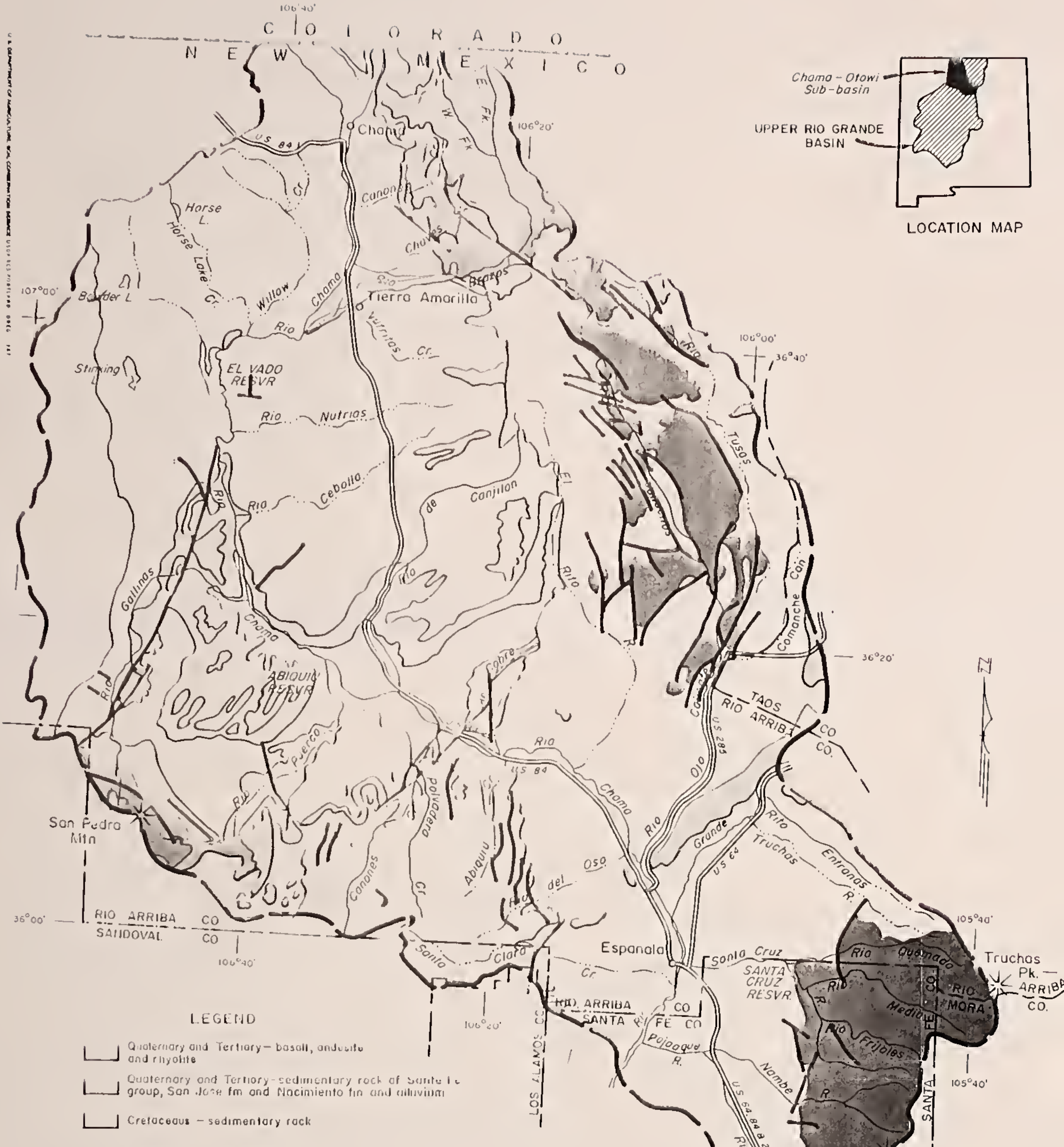


LAND STATUS MAP
CHAMA-OTOWI SUB-BASIN
UPPER RIO GRANDE BASIN
NEW MEXICO



LEGEND

- Quaternary and Tertiary – basalt, andesite and rhyolite
- Quaternary and Tertiary – sedimentary rock of Santa Fe group, San Jose fm and Nacimiento fm and alluvium
- Cretaceous – sedimentary rock
- Jurassic – sedimentary rock
- Triassic – sedimentary rock
- Permian – sedimentary rock
- Pennsylvanian – sedimentary rock
- Precambrian undivided – granite, schist, quartzite, and other rocks
- Contact
- Fault

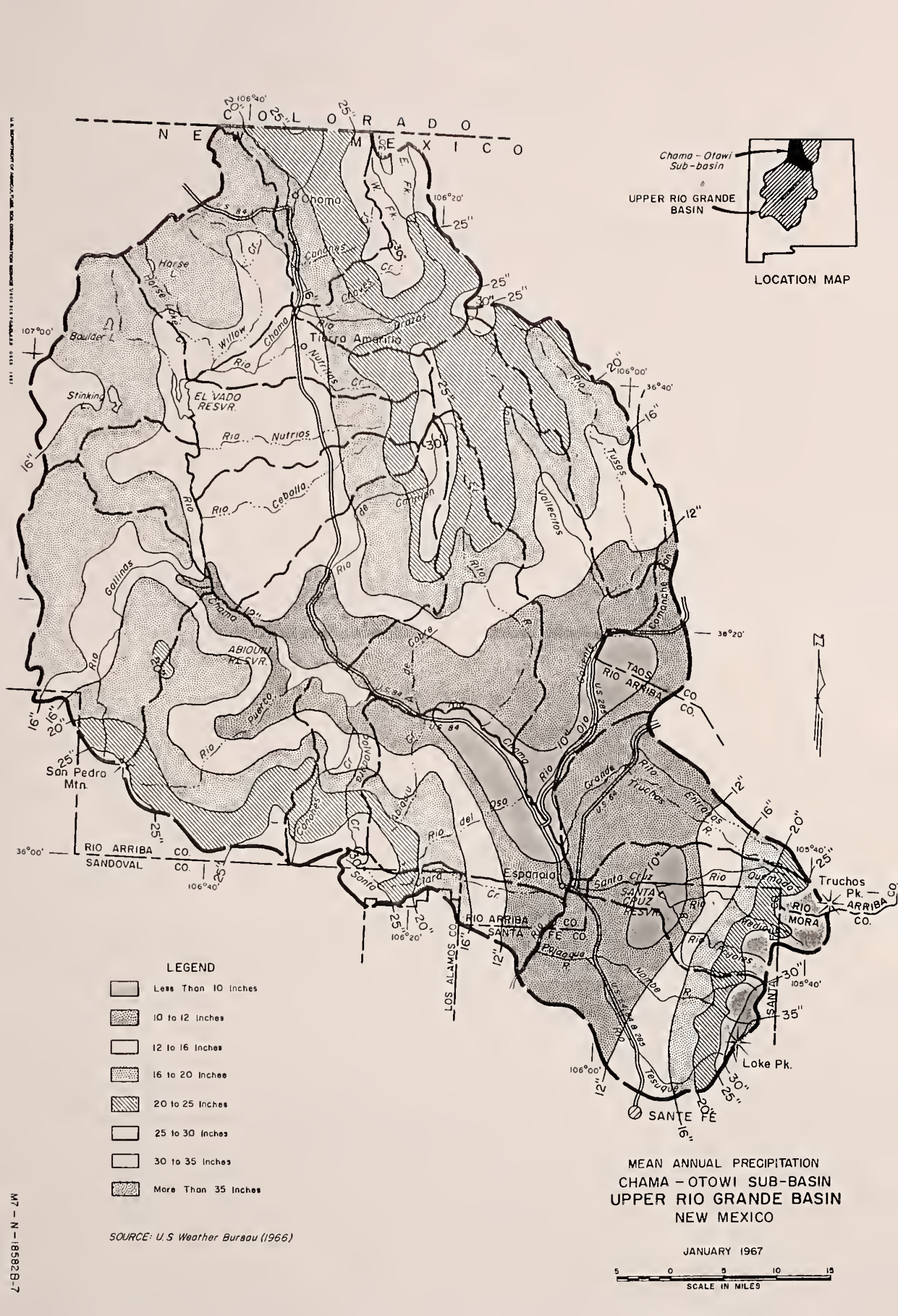
Modified from Miscellaneous Geologic Investigations MAP-I 224, C H Dane and G O Bachman, 1957, New Mexico Bureau of Mines and Mineral Resources.

GEOLOGY MAP
CHAMA – OTOWI SUB-BASIN
UPPER RIO GRANDE BASIN
NEW MEXICO

JANUARY 1967

SCALE IN MILES: 5 0 5 10 15

M7 – N – 18582B-6



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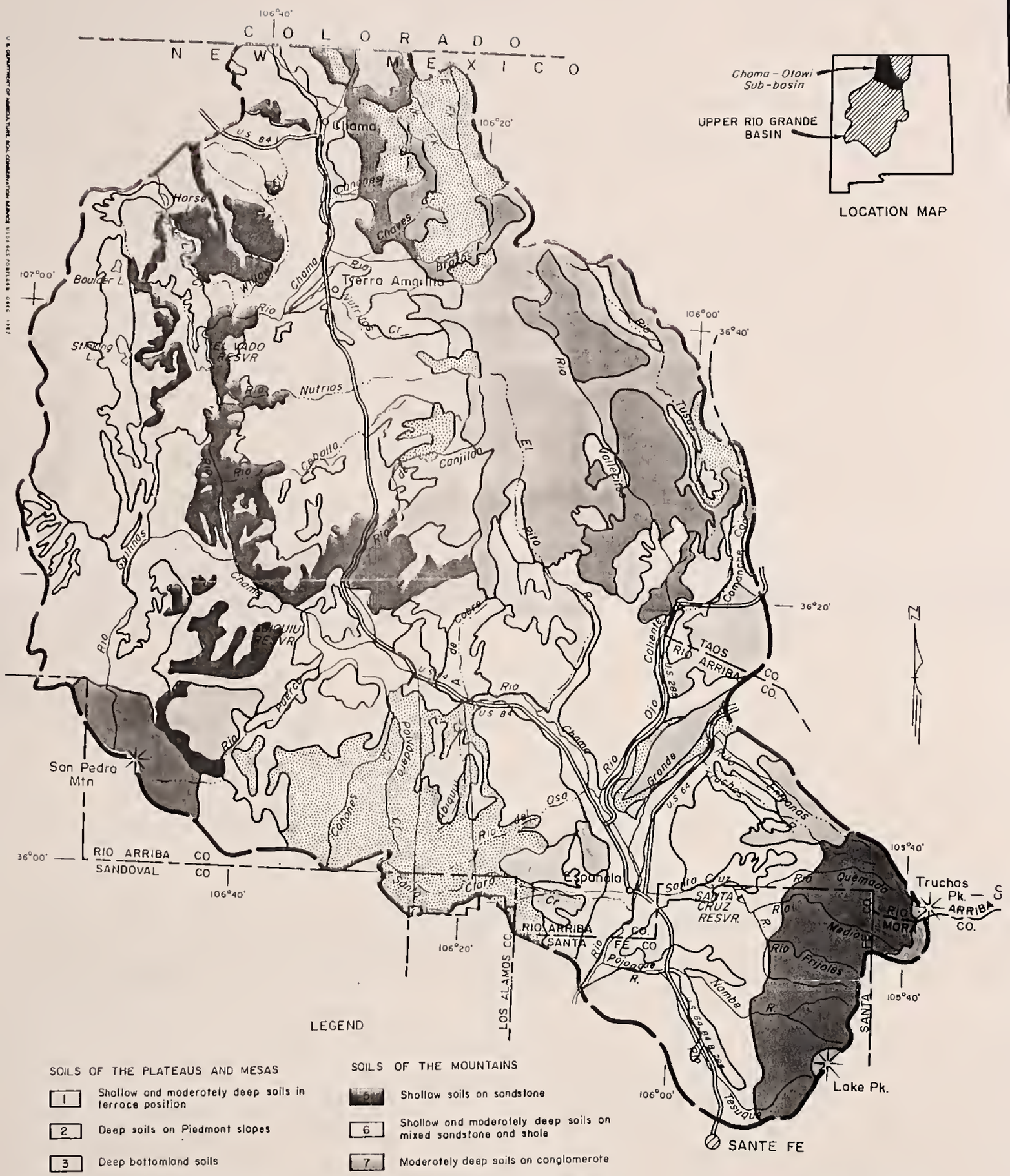


MP-N-18528-8

M7 - N - 18582C-3

COLORADO
NEW MEXICO
Chama
Tierra Amarilla
EL VADO RESVR.
ABIQUIU RESVR
SANTA CRUZ RESVR.
Espanola
SANTE FE
San Pedra Mtn.
Lake Pk.
Truchas Pk.
Chama - Otowi Sub-basin
UPPER RIO GRANDE BASIN
LOCATION MAP
RIO ARRIBA CO.
SANDOVAL CO.
SANTA FE CO.
TAOS CO.
LOS ALAMOS CO.
106°40'
106°20'
106°00'
105°40'
36°40'
36°20'
36°00'
107°00'
LEGEND
36 New Mexico Plateaus and Mesas
48 Southern Rocky Mountains
51 High Intermountain Valleys
SOURCE: USDA-SCS Handbook 296 and Subbasin Soil Map
MAJOR LAND RESOURCE AREAS
CHAMA - OTOWI SUB-BASIN
UPPER RIO GRANDE BASIN
NEW MEXICO
JANUARY 1967
SCALE IN MILES
M7 - N - 185828-2

106°40'
C O L O R A D O
N E W M E X I C O
D. & R. G. W.
Chama
106°20'
U.S. 84
107°00'
N.M. 95
Tierra Amarilla
(Planned)
Tusas
106°00'
36°40'
EL VADO RESVR.
El Vada
Rio
N.M. 111
Vallecitos
N.M. 112
Canjilan
N.M. 110
N.M. 100
El Rita
Chama
ABIQUIU RESVR.
U.S. 84
96 N.M.
Oja Caliente
36°20'
Gallina
N.M. 96
Cayate
Abiquiu
Rio
Chama
Rio
U.S. 285
Rio
U.S. 64
RIO ARRIBA CO
TAOS CO.
SANDOVAL CO
36°00'
106°40'
Espanola
105°40'
RIO ARRIBA CO
SANTA FE CO
106°20'
N.M. 4
LOS ALAMOS CO
U.S. 64, 84 & 285
106°00'
SANTE FE
RIO ARRIBA CO
RIO MORA CO.
SANTA FE CO
105°40'
Chama - Otowi Sub-basin
UPPER RIO GRANDE BASIN
LOCATION MAP
LEGEND
Landing Strip
1966 TRANSPORTATION ROUTES
CHAMA - OTOWI SUB-BASIN
UPPER RIO GRANDE BASIN
NEW MEXICO
JANUARY 1967
5 0 5 10 15
SCALE IN MILES
7-N-18582B-9

SOURCE: Subbasin Soils and Vegetation Maps

LEGEND

FOREST - WOODLAND

- Spruce-Fir, strip or block cut, thin
- Ponderosa-Pine, strip or block cut thin and prune
- Pinyon-Juniper, clear and reseed to grass-gully control
- Pinyon-Juniper, thin and reseed to grass-gully control
- Aspen monogement
- Stony land, good resource management

BRUSHLAND

- Brush (Chaparral), clear and reseed to grass
- Sagebrush, clear and reseed to grass - gully control
- Phreatophyte, control and reseed to grass

GRASSLAND

- Grassland management
- High altitude grassland, snow fence

CULTIVATED LAND

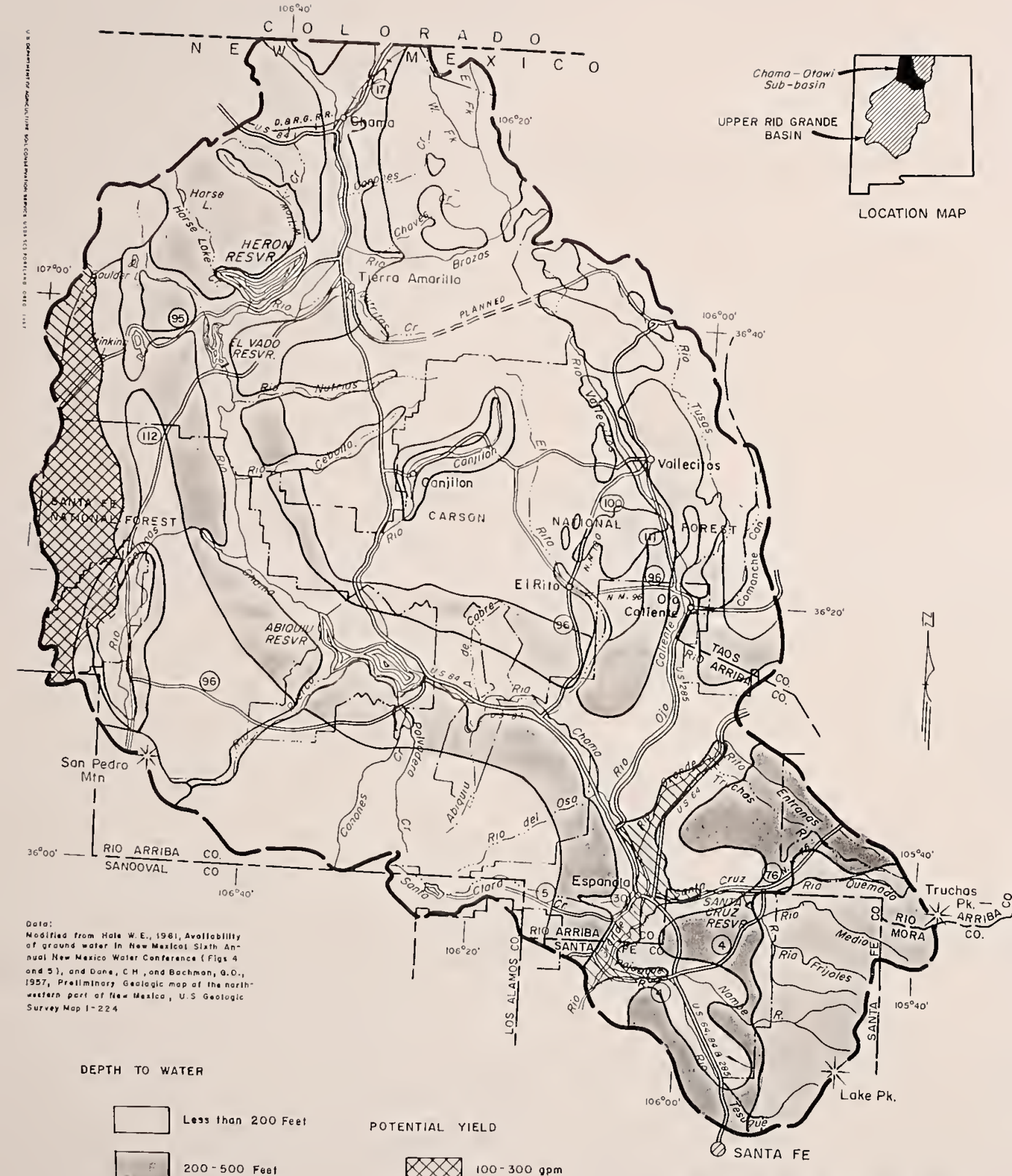
- Cultivated land treatment, irrigated and dry
- Abandoned cropland, gully control and reseed to grass

LAND TREATMENT MAP
CHAMA - OTOWI SUB-BASIN
UPPER RIO GRANDE BASIN
NEW MEXICO

JANUARY 1967

5 0 5 10 15
SCALE IN MILES

M7 - N - 18582C-2



Data:
Modified from Hale W. E., 1961, Availability of ground water in New Mexico: Sixth Annual New Mexico Water Conference (Figs 4 and 5), and Dane, C. H., and Bachman, G. O., 1957, Preliminary Geologic map of the northwestern part of New Mexico, U.S. Geologic Survey Map I-224

DEPTH TO WATER

- Less than 200 Feet
- 200 - 500 Feet
- More than 500 Feet
- Areas in which crystolline rocks predominate and are assumed to be dry.

POTENTIAL YIELD

- 100 - 300 gpm
- Over 300 gpm

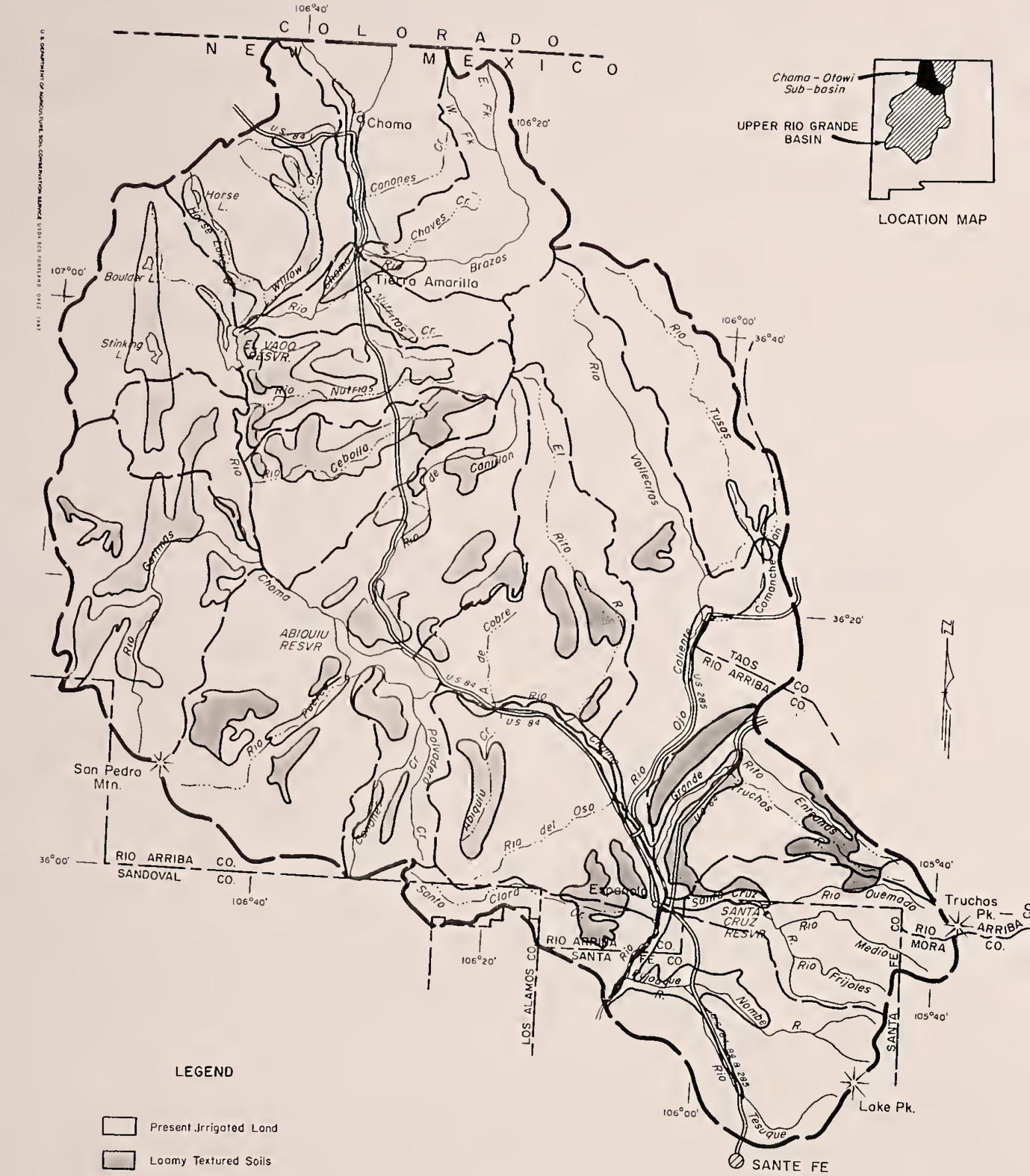
Note: Areas without line patterns less than 100 gpm

DEPTH TO AND YIELD OF RELATIVELY FRESH GROUND WATER
CHAMA - OTOWI SUB-BASIN
UPPER RIO GRANDE BASIN
NEW MEXICO

JANUARY 1967

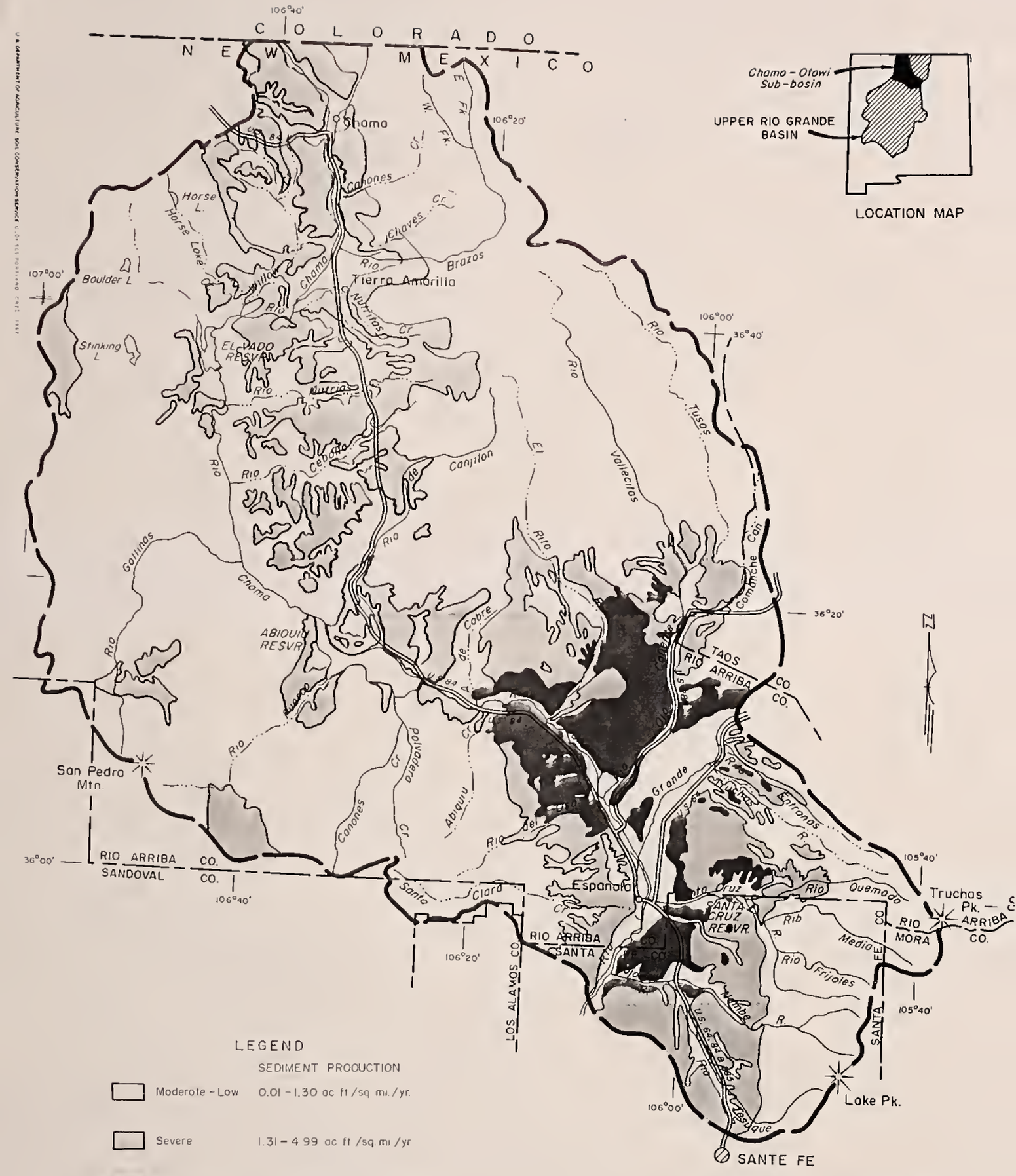
5 0 5 10 15
SCALE IN MILES

M7 - N - 18582



U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, USDA-SCS-PORTLAND, OREG. 1967

M7 - N - 185828-3



U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

M7 - N - 18582-B-4

LEGEND

SEDIMENT PRODUCTION

☐	Moderate-Low	0.01-1.30 ac. ft./sq mi./yr
☐	Severe	1.31-4.99 ac. ft./sq mi./yr
■	Very Severe	5.00 or more ac. ft./sq mi./yr.

SOURCE: USDA River Basin Party

* Erosion to be expected if protective vegetation is removed by cultivation, fire, heavy grazing or by other means

EROSION HAZARD MAP*
CHAMA - OTOWI SUB-BASIN
UPPER RIO GRANDE BASIN
NEW MEXICO

JANUARY 1967

5 0 5 10 15
SCALE IN MILES

M7-N-185828-5

AREAS OF POTENTIAL INCREASED WATER YIELD DUE TO LAND TREATMENT

CHAMA - OTOWI SUB-BASIN

UPPER RIO GRANDE BASIN

NEW MEXICO

JANUARY 1967

SCALE IN MILES

M7-N-18582

CNI NO.	WATERSHED
I-144 & I-145	Pojoaque Creek
I-146	Santa Cruz River
I-147	Santa Clara Creek
I-149 & I-150	Sebastian Martin
lc-2 & I-148	Espanola-Rio Chama
lc-1, lc-6, lc-7	El Rito
lc-3 & lc-4	Rio Vallecitos
lc-5	Rio Tusas
lc-8	Canones Creek
lc-9	Arroyo Seco
lc-10	Rio Puerco
lc-11	Rio Cebolla
lc-12	Rio Gallinas
lc-13	Arroyo del Puerto
lc-14	Rio Nutrias
lc-15	Boulder Creek
lc-16	Rio Tierra Amarilla
lc-17	Willow Creek
lc-18	Rio Brazos
lc-19	Rio Chama

PL 566 STATUS

- Planning Suspended
- Completed Project
- Planning Completed
- Investigation indicates justifiable project under PL 566

PL566 PROJECTS
CHAMA - OTOWI SUB-BASIN
UPPER RIO GRANDE BASIN
NEW MEXICO

JANUARY 1967

SCALE IN MILES 5 0 5 10 15

U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE 1:500,000 PORTLAND, OREG. 1967

M7 - N - 18582C-1

WATER DEVELOPMENT PROJECTS

OPERATING

1. El Vado Reservoir
2. Santo Cruz Reservoir
3. Abiquiu Reservoir

USBR PROJECTS UNDER CONSTRUCTION

4. Azotea Tunnel
5. Heron Reservoir

USBR AUTHORIZED PROJECTS

10. Pojoaque Unit
11. Llano Unit

US ARMY CE AUTHORIZED PROJECTS

21. Rio Grande Floodway

USDA PROJECT POSSIBILITIES

PL 566

18. Sebastion Martin-Block Mesa
19. Espanola-Rio Chama

POSSIBLE UNDER ANY OF SEVERAL LEGISLATIVE AUTHORITIES

6. Barronco Project
7. Ensenado Project
8. El Rito Project
9. Rio Ojo Caliente Project
12. Chama Dam (Recreation)
13. TA Creek Project
14. Abiquiu Creek Dam (Recreation)
15. Vallecitos Dam (Recreation)
16. Del Oso Dam (Recreation)
17. Truchas Dam (Recreation)
22. Chama Channel Improvement

PROJECT LOCATION MAP

CHAMA - OTOWI SUB-BASIN

UPPER RIO GRANDE BASIN

NEW MEXICO

JANUARY 1967

SCALE IN MILES 5 0 5 10 15

M7 - N - 185828-1


COLORADO
NEW MEXICO
Continental Divide National Trail
Chama
Tierra Amarilla
HERON RESVR.
EL VADO RESVR.
ABIQUIU RESVR.
Conjilon
Vallecitos
El Rito
Ojo Caliente
Espanola
Truchos Pk.
Lake Pk.
SANTA FE
San Pedro Mtn
SANTA FE NATIONAL FOREST
de CARSON NATIONAL FOREST
RIO ARRIBA CO.
SANDOVAL CO.
TAOS CO.
SANTA FE CO.
LOS ALAMOS CO.
RIO MORA CO.
PLANNED
National Trail
Chama - Otowi Sub-basin
UPPER RIO GRANDE BASIN
LOCATION MAP
LEGEND
Potential Federal Recreation Site (Number indicates multiple sites)
Existing Federal Recreation Sites (Number indicates multiple sites)
Potential State Recreation Site
Existing State Recreation Site
Potential Private Recreation Site
Existing Private Recreation Site
National Forest Land
State Land
Potential Water Impoundments (Number Indicates Multiple Sites)
RECREATION SITES
CHAMA - OTOWI SUB-BASIN
UPPER RIO GRANDE BASIN
NEW MEXICO
JANUARY 1967
SCALE IN MILES
5 0 5 10 15
MT - N - 18582